Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JANUARY, 1912.

EDITORIAL.

In answer to the request which has been printed on the cover of "KNOWLEDGE," many of our readers have been so good as to write and point out the particular branches of science in which they are most interested. Judging from the past history of the Magazine, and from the fact that there is no other that deals with Astronomy in quite the same way, it was to be expected that this subject would have the most votaries. Such was found to be the case and we would ask our astronomical readers to make known to their friends, especially those abroad, the fact that Dr. Crommelin is expanding the column entitled "The Face of the Sky," as well as publishing his material two months in advance so that it may reach subscribers in most parts of the world in time to be of service to them.

The success of any undertaking is dependent to a large extent upon the co-operation of every one concerned, and astronomers could help us most materially by giving information to us as to photographs of interest which they would like to see reproduced as plates in the pages of "KNOWLEDGE."

The microscopists came in a very excellent second, and to them it may be said that an endeavour will be made to extend the scope of the microscopical column, and, in the near future, to introduce special articles which will appeal to them. About equal numbers of our readers occupy themselves with chemistry and physics and the natural history sciences, but there is a slight preponderance of botanists over geologists, and of the latter over those who specialise in zoölogy.

With regard to the first two sciences it must be owned that we have some difficulty in obtaining just the sort of articles which are suitable for the pages of "KNOWLEDGE." There is a tendency for them to be too highly specialised, but so much original work is being done in these subjects at the present day that it is not easy for those engaged in it to get their results published promptly. There must be much among their researches that would appeal to the amateur, and we invite chemists and physicists to make suggestions on these matters to us for the mutual advantage of ourselves and our readers.

We thank our numerous correspondents for their kind criticisms and commendations. Several have expressed a desire that "KNOWLEDGE" should be made more like the old *Hardwicke's Science Gossip*, the title of which is incorporated with our own. Knowing, as we do, something of the working of *Science Gossip*, we may say that practically everything which appeared in it was written for love, by the readers themselves, and the times seem somewhat to have changed since then. It has been, however, our endeavour to provide, in accordance with precedent, some articles which will appeal to all those who are interested in the world around them, and the attention which these contributions have aroused has been reflected in the columns of our contemporaries. We should therefore be particularly glad to hear from possible contributors, in this or any of the directions which we have previously indicated.

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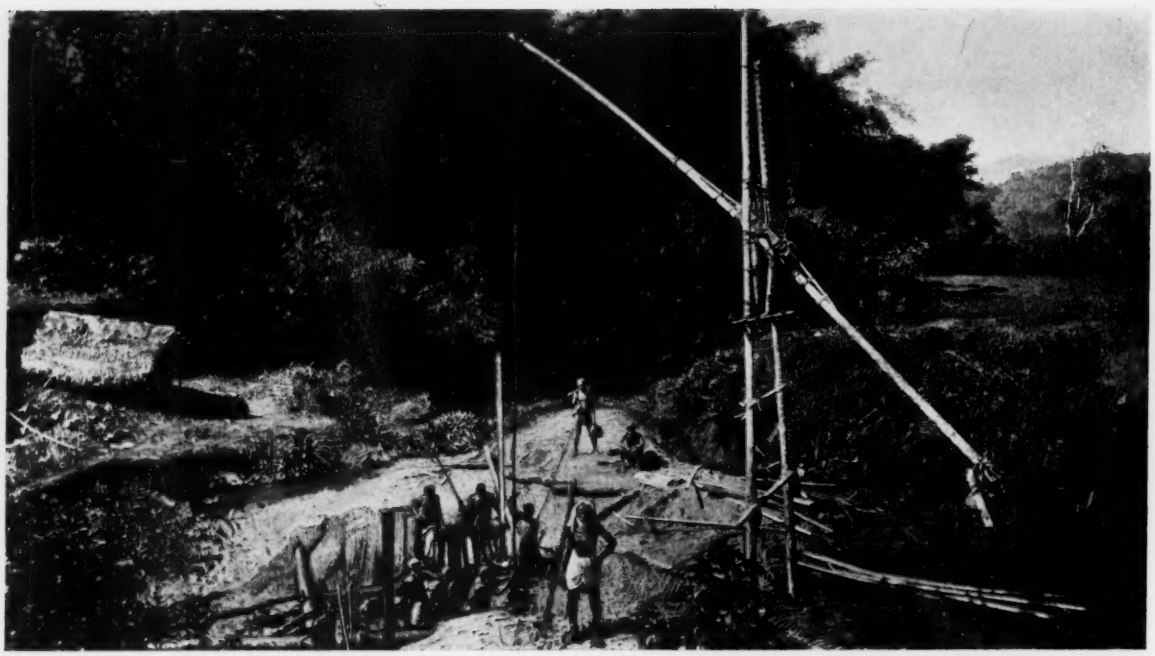


FIGURE 1. Gem pit showing primitive crane and pool at which the earth is washed for gems.

CEYLON: THE ISLAND OF JEWELS.

By LEOPOLD CLAREMONT.

Author of "The Gem-Cutter's Craft," and "The Identification of Gems."

THE gem-minerals with which Ceylon is so generously endowed are remarkable, not only for their beauty, but also on account of the great variety of them.

Although the diamond, opal, emerald, and peridot are conspicuous by their absence, all the other well-known transparent gems are abundantly represented in the island. There are also many very beautiful precious stones with which the general public at all events, is more or less unfamiliar.

The principal mineral is corundum, of which the red and blue varieties constitute the gems ruby and sapphire. (See Figure 2.) It, however, also occurs in a long series of different colours of varying shades, which range from the ruby-red to delicate rose pink; from the royal sapphire to sky-blue; from plum to violet and lilac; and from golden orange to primrose.

There is also a most attractive rich salmon-pink variety, resembling the tint of the "Sunrise" rose, and which is known in Ceylon as *padparagum:* and very rarely only, the mineral is found green in the island.

From a specimen in the British Museum.

FIGURE 2.
A somewhat water-worn crystal of Sapphire.

In Central Queensland, however, at a place called Anakie, the green variety is fairly plentiful while the red and purple are entirely absent.

Some of the corundum gemstones exhibit the phenomenon of *asterism*, that is, they display a bright shimmering six-pointed star with the rays divergent from the centre of the stone when it is cut with a smooth convex surface.

They are found almost exclusively in Ceylon (a few ruby star-stones are found in Burmah), and under the name of *asterias* or *star-stones* are highly valued by connoisseurs when of choice quality. For some unknown reason, the yellow and green varieties of corundum do not exhibit the phenomenon of asterism.

Another gem-mineral which

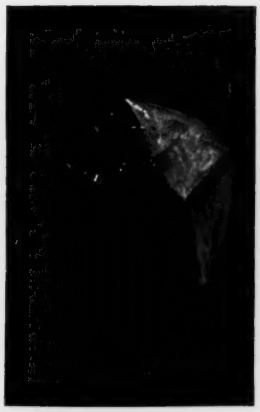
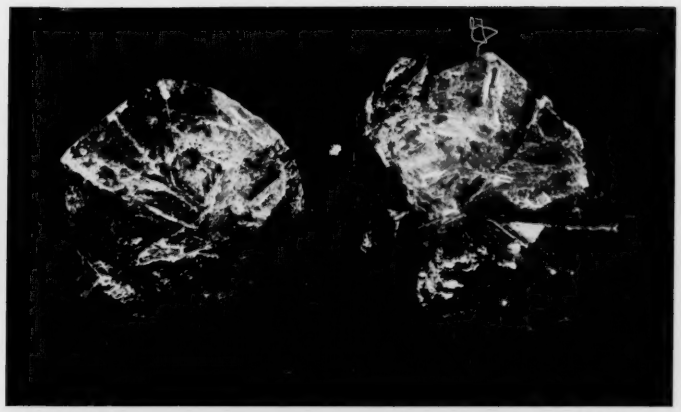


FIGURE 3.

Crystal of Jargoon or Zircon (actual size).

When cut as facetted stones, jargoons possess the power of dispersion of light approaching in some cases to that of the diamond.

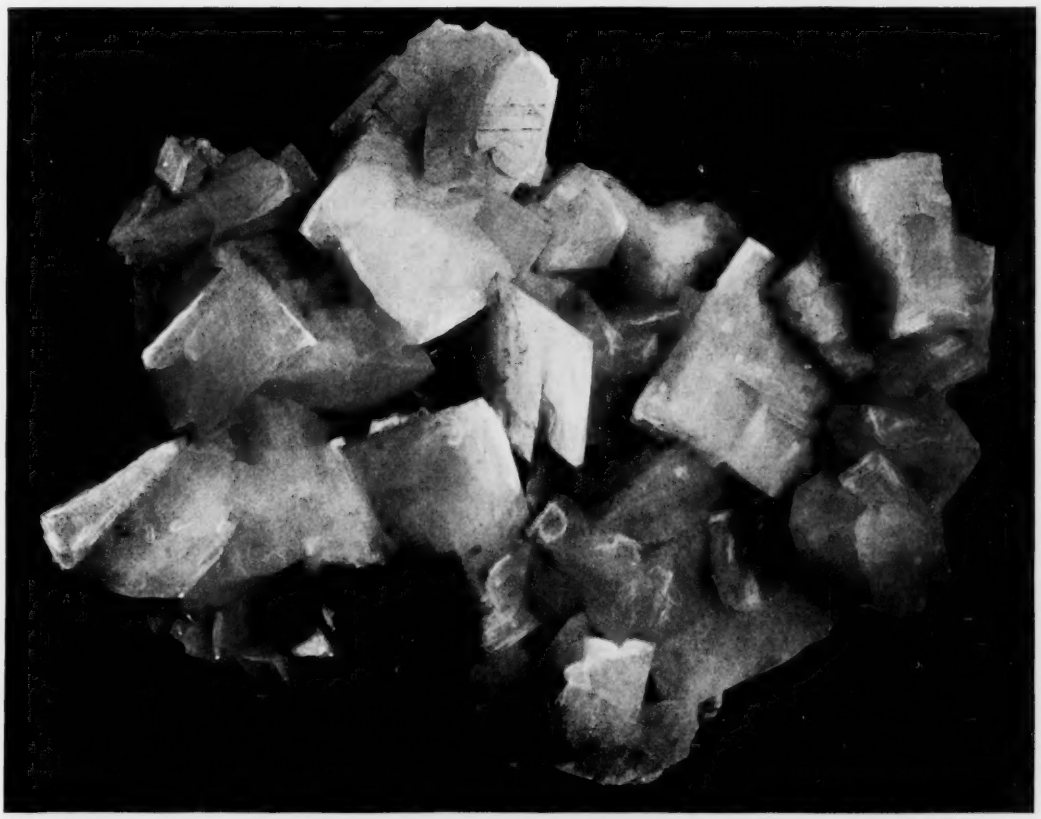


From a specimen *in the British Museum.*

FIGURE 4.

Crystals of Alexandrite (actual size).

The alexandrite and cat's-eye are both varieties of the mineral chrysoberyl, and in very rare cases the cat's-eye variety also possesses the power of alteration of colour. Although Ceylon is the chief source of the alexandrites and the sole source of the cat's-eye, the most choice specimens of the former are derived from Siberia.



From a specimen *in the British Museum.*

FIGURE 5. Crystals of Adularia or Moonstone (actual size).

These gems are almost colourless and transparent by transmitted light, but display when cut with a smooth convex surface (*en cabochon*) a white or bluish blush or spot from which they take their name.

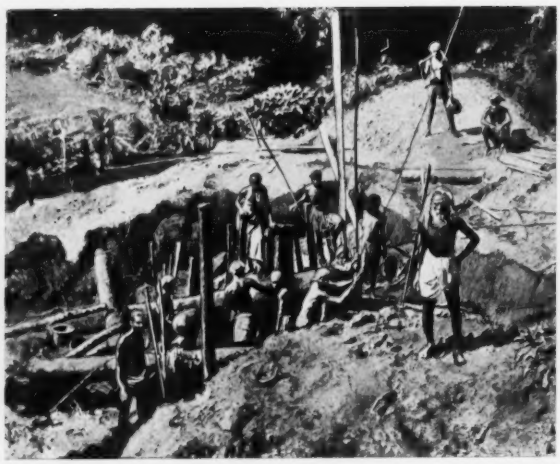


FIGURE 6.
Natives of Ceylon working a gem pit.

FIGURE 7.
The "gemming" basket in use.

possesses a similarly extensive range of colour, except that yellow is missing, is the spinel. Some specimens of this, somewhat resemble rubies and sapphires, and are therefore often described as "spinel rubies," and "spinel sapphires" respectively. It is, however, very much softer than corundum, and is one of the three gem-stones, occurring in the form of crystals, which are singly refractive, the other two being diamond and garnet.

There is a remarkable flame-red variety of spinel, the colour of which is unique in the whole mineral world, not even excepting the ruby. It is an exquisite gem of great value.

The chrysoberyl is an attractive gem stone, although its beauty is somewhat unappreciated. It occurs in shades of Autumn green, brown, and yellow, and possesses great brilliancy. There are, however, two varieties of this gem-mineral which form well-known and valuable precious stones: of these, the most important is known as the *alexandrite*. (See Figure 4.) Fine examples of this gem by daylight appear pistachio-green, changing to rich mulberry-red by artificial light.

Ceylon is the chief source of alexandrites, although a few are found in Siberia.

The other important variety of chrysoberyl is the *cymophane* or cat's-eye, which, when cut with a smooth convex face presents a narrow white line glittering across it, which has a fancied resemblance to the iris of a cat. The position of the line or ray alters as light strikes it from different angles, giving a peculiarly mysterious effect. Cymophanes are only found in Ceylon.

The rarest and most curious of all precious stones are those cat's-eyes which change from green to red, as do the alexandrites.

FIGURE 8.
The basket is handled with a circular movement.

FIGURE 9.
The lighter stones slip over the edge of the basket.

By the superstitious natives the cymophane is considered to be an entombed spirit, and this can be more readily understood than many other similar conceits, because of the strange resemblance of the stone to the eye of an animal.

Many shades of soft yellow, brown, cinnamon and green are displayed by specimens of the mineral jargoon or zircon. (See Figure 3.) This gem-stone is strangely unappreciated, for not only is the colouring most pleasing, but the brilliance is second only to that of the diamond.

Another reason why the neglect of the zircon is unaccountable is that this beautiful gem is comparatively inexpensive.

The writer has only space briefly to complete the list of precious stones of Ceylon, for his object is to give the reader some idea of the manner in which they are handled.

There are garnets, red, brown, violet and cinnamon; topazes, white and blue; tourmalines, red, claret, green, yellow and blue; aquamarines or beryls, sky-blue and sea-green; besides iolotes and moonstones. (See Figure 5.)

FIGURE 10.
Native gem cutters at work with the overseer watching them.

From the foregoing paragraphs it should be apparent that these gems present a pageant of colour unequalled by those of any other district.

From the finding of a precious stone in a river-bank or gem-pit, to its use as a jewel by a woman of fashion, it passes through many strange hands, and undergoes much alteration in appearance.

The securing, cutting, polishing and marketing of such a large number of gems necessarily comprise an important industry. The entire trade is controlled locally by the Moormen, many of whom are extremely wealthy.

The foremost of them not only buy up the most important stones as they are found from time to time, but send out expeditions into the principal gem-producing areas to search for them. They all either retain their own cutters or superintend the work given out to be done. No foreigner is admitted within the magic circle of the Moormen except as a customer.

The Moormen are descendants of the Moors who once occupied Ceylon, and of whose forts large ruins still exist in the island.

The value of the precious stones annually exported to Europe and America from Ceylon is estimated at three million pounds, and high prices, especially for choice specimens, are realised locally from travellers and tourists.

The gem-stones are of igneous origin, and have been loosened from the granite and gneissic rocks in which they were formed, by disintegration. They are found in a stratum of alluvial gravel which is known to the natives as "illam," which is reached by digging pits of from three to thirty feet in depth. They are generally in the form of more or less water-worn nodules, undamaged crystals being very rare. (See Figure 2.)

When the pits are deep, the illam is hoisted to the surface by means of a primitive kind of wooden crane (see Figure 1), and it is then carried to the nearest stream or pool to be washed.

It is often found, in low-lying spots, that old disused gem-pits which have become filled with water, are available for the washing of the gem-bearing material.

The illam consists of gravel embedded in yellow or reddish clay, and is usually brought to the surface in a dry condition, but when the gem-pit is below the level of a neighbouring stream, it is rather muddy.

Sometimes the stratum of illam *crops out*, or is exposed upon the surface of the country, and this is generally found to occur on the slopes and banks of rivers and streams. When this is the case, very little excavation is done, as the material is more easily obtainable.

The searching for gems is carried on from October to March. The washing is done by means of a circular basin-shaped basket, about twenty-eight inches in diameter and twelve in depth, which is called a "gemming basket": the native wading up to his knees holds the basket in the water. (See Figure 7.)

A circular turning movement (see Figure 8) is given to the basket, which is occasionally allowed to tilt below the surface of the water, and in this way the lighter stones slip over the edge, and the heavier ones remain in the basket. (See Figure 9.)

After a good many baskets full of gravel have been washed in this way, the residue, which is found to contain thorianite and thorite and other heavy minerals, is carefully searched for gem-stones.

The number of gems found of insignificant value is extremely large in proportion to that of the choice specimens, so that often a great deal of work is done before there is any prospect of recompense.

When an important stone is discovered there is great excitement among the natives, and many would-be buyers eagerly endeavour to outdo each other in obtaining a bargain. The price asked is

XUM

generally several times greater than that which is eventually accepted, and by continual bartering, the gem changes hands repeatedly.

Also, there are ever ready pilfering fingers to purloin from the rightful owner, or to substitute an inferior stone for one of good quality. The diggers and washers are continually watched to prevent anything of the kind from taking place.

FIGURE 11.

A Moor Lapidary, Ceylon.

It is a matter of great difficulty for Europeans to obtain details or photographs of the gemming industry, for the natives are very jealous and secretive, and object to company upon their expeditions. They are also exceedingly superstitious, and believe in all sorts of devils and evil omens; they will not even allow one of their own women to go near a gem-pit, because she would be sure to bring bad luck to it.

There are several extensive districts in the island where precious stones occur, but the most productive locality is the hilly country of Saffragan, the chief town of which is Ratnapura, or in other words "the city of rubies."

Nearly all the different kinds of gems are found occurring together, the exceptions being moonstones, amethysts, and alexandrites, the last of which are principally derived from Galle.

The natives have a great prejudice against sending gems out of the island in the rough state, and always cut and polish them locally. This is due to their anxiety to see exactly to what extent the beauty of each stone is developed by the cutting, and thus accurately to estimate the value. They do not care to part with the rough stones, for Europeans to reap the benefit of any increase in value.

The cutting and polishing is done by the Singhalese upon perpendicular leaden wheels, smeared with emery, against one side of which the gem is pressed with the left hand, while the wheel is rotated by means of a bow and cord held in the right. (See Figures 10 and 11.) The whole apparatus is most simple and primitive, the success of the work depending entirely upon the skill of the operator.

The cutters squat upon their haunches behind the wheels, and sometimes an overseer watches the progress of work to prevent theft. (See Figure 10.) Much of the cutting is done by the roadside in view of every passer-by, but many little "tricks of the trade" are withheld from public view.

The native gem-cutters' chief object is to so manipulate the precious stone that the maximum of size and weight is retained, often to the sacrifice of symmetry and brilliancy. They are wonderfully adept at retaining and regulating the colour, which in some gem-stones is not of uniform density throughout, and in dexterously hiding feathers and flaws. Owing, however, to irregularity, and also the want of symmetry and proper proportion, it is

FIGURE 12.

The gems of Ceylon are recut in Europe.

generally found that the gem-stones in the "native-cut" condition are unsuitable for the requirements of high class European jewellery. It is therefore necessary, before they can be used for the purpose, that they shall be re-cut by a skilled lapidary with a knowledge of mineralogy and optics.

In principle, the apparatus used by the European gem-cutter is similar to that used by the Moor in Ceylon. The wheel is, however, made of copper and diamond dust, and revolves horizontally instead of perpendicularly (see Figure 12).

The operator sits at a bench and places the gem, mounted on a small ebony holder, against the surface of the wheel which he rotates by means of a crank held in the left hand. Although the apparatus is simple, much expert knowledge, skill and experience are requisite for success in this delicate and artistic craft.

CORRESPONDENCE.

THE NEED FOR TELESCOPES.

To the Editors of "KNOWLEDGE."

SIRS,—It is indeed strange, as Professor Bickerton observes, that Astronomy has not a greater hold on the human mind. But perhaps the general public are not altogether to blame for their neglect of that glorious science. Compare, for instance, the facilities enjoyed by townspeople for literary study, with the opportunities given them to use a good telescope in conjunction with star maps and text books. Where can the "man in the street" go to feast his eyes on the clusters so eloquently described by Professor Bickerton?

Years ago I was young and naïve enough to ask if I might go to Greenwich to look through the Observatory telescope. I can well understand that casual amateurs would interfere with investigations at the great centres of observation. But, surely, reading rooms, libraries and village clubs here and there might be provided in an upper floor with a 4½-in. telescope, under the care of some responsible person in the neighbourhood, who would instruct an attendant.

Wanted, then, a scientific Carnegie to provide telescopes.

No doubt that the taste for star-gazing is growing, and that the *Daily Telegraph* reflected general interest in publishing monthly charts of the sky.

Professor Bickerton's shepherds and, I would add, fishermen, would appreciate, even more fully than they do, the beauty of the heavens, when they learnt to identify groups in single stars, and could follow their motions. Their educated friends should pass on some elementary knowledge to simple people by the only sure methods, namely, by pointing out constellations in stars when opportunity offers, and especially drawing attention to their changing positions as time goes on.

L. M. M.

WAREHAM.

METEORS.

To the Editors of "KNOWLEDGE."

SIRS,—Will you allow me a little space in your valuable paper in which to make an earnest appeal to all amateurs who are interested in meteoric observations?

Too little regular work is done in England and, with the successful example of Mr. Denning before us, we in this country who are at all enthusiastic in the matter, might do much work that would be valuable if only we undertook to systematically watch the sky and furnished full reports of our seeings to someone qualified to investigate them.

For many months past my husband and myself have observed every fine evening at regular hours and sent in frequent reports to Mr. Denning with whose results we have had many interesting accordances. Unfortunately as he is not well now and his work limited, many of our observations are of little use, as of course it is only by two observations of the same meteors in different places, that any accurate knowledge can be obtained of their real paths. Will some amateurs who care about this branch of astronomy agree to watch regularly, evening by evening, at stated times, and send us each week or month their records, which we can then compare with ours and write out both together and send to Mr. Denning or some other authority.

If two hours or more are too long the time could be divided, and each observer have perhaps half an hour or so, we could easily manage to arrange in a way suitable to everyone's wishes. It is such interesting work! All day long I look forward to the silent hours when our watch begins, the stars seem no longer far-away twinkling lights, but intimate friends, and each moment is filled with the glow of anticipation as to what grand meteor will next appear on the scene.

In our observations we record the times, magnitudes, Right Ascension and Declination, of appearance and disappearance, direction of flight, details of colour, train or trail, and so on. If any of those who, after this appeal, consent to watch, do not care to spend time in determining the Right Ascensions and Declination, or the altitude or azimuth, the name of the star where the meteor appeared to come, and the one where it appeared to go to, will be quite sufficient, if they will kindly mention the name of the star atlas they use, as some of the smaller stars have different letters or numbers in different maps, and it might be difficult to trace them. My address is—Zavijava, Hansol Road, Bexley Heath.

FIAMMETTA WILSON.

TO FIND APPROXIMATELY SIDEREAL TIME.

To the Editors of "KNOWLEDGE."

SIRS,—May I add a post-script to my letter of November giving the equation R.A.=h+2 m+5 as an approximate index to Sidereal time?

As a practical application of the equation I have marked on my watch-dial +0 against IX, +6 against XII, and +12 against III to remind me that on 22nd September Sidereal and clock time are the same, and that in December the difference is six hours, and in March 12 hours.

LYNDHURST. FRED B. TAYLOR.

THUNDERSTORMS.

To the Editors of "KNOWLEDGE."

SIRS,—I have been for a great number of years a very careful observer of Thunderstorms and Electrical Phenomena in this and other countries, and possibly some day I may trouble you with a few of my notes. But I write now to put a question to your readers which is perhaps more amusing than scientific. Inasmuch as the world is round and thunderstorms like everything else have a beginning, it follows that the first flash of lightning in any storm must be directly over somebody's head. How is it then that we cannot meet with anyone who remembers anything of the sort? We are invariably told that distant thunder was heard, or, if by night, distant lightning was seen near the horizon, and the storm gradually approached. *The Times*, in describing a storm in London, always begins in this way—"Heavy clouds were observed in the West and a little later distant thunder was heard, and at such and such a time the storm broke over London." This, too, is the way local newspapers always describe storms. Considering how common in the late spring thunder showers are, it seems strange that wherever we are they always make their first appearance in the distance.

TANKERVILLE CHAMBERLAYNE.

WINCHESTER.

XUM

MR. ROBERTSON *versus* MR. PROCTOR.

To the Editors of "KNOWLEDGE."

SIRS,—Many of your readers will doubtless be interested to learn that Mr. John M. Robertson, M.P., in his "Letters on Reasoning," claims to have shown that the founder of this journal "falls into pure absurdity" in his exposition of the mathematical theory of Probability. I have written to him privately pointing out that his argument is founded on a blunder due to a carelessness that is very inappropriate in dealing with an eminent man of science, and urging that his book should be provided with an erratum slip doing justice to Mr. Proctor; but his reply makes it clear that he intends to leave his book as it stands, and I therefore trust that you will allow me to deal with the matter in your columns.

In No. VII of his "Letters" above referred to, Mr. Robertson quotes Mr. Proctor's statement that in the many thousands of experimental coin tossings by Buffon and others, a succession of twelve heads (which frequently occurred) was followed by another head as often as it was followed by a tail; and he says that, in making this statement, Mr. Proctor was "in effect asserting that in the given experiments runs of thirteen heads were exactly as common as runs of twelve, and if his argument were coherent, he was committed to arguing that runs of fourteen were as common as runs of thirteen, and so on indefinitely." Now, a moment's consideration ought to show that Mr. Proctor was simply asserting, in effect, that runs of thirteen *or more* were as common as runs of twelve; but as Mr. Robertson professes not to see this, I will now make the matter even more simple than I did in my letter to him.

According to Mr. Proctor's statement, it will be seen that if there were *four hundred cases* in which *twelve heads* were followed by a tail, there would also be four hundred in which they were followed by a thirteenth head; and out of the latter four hundred, there would be *two hundred* in which *thirteen heads* were followed by a tail, and two hundred in which they were followed by a fourteenth head; and out of the latter two hundred there would be *one hundred* in which *fourteen heads* were followed by a tail, and one hundred in which they were followed by a fifteenth head; and so on. It is thus clear that Mr. Robertson is altogether wrong when he goes on to say that Mr. Proctor's statement implies that runs of a thousand would be as common as runs of three; and I trust he will now admit that his supposed proof of Mr. Proctor's "pure absurdity" is founded on a misunderstanding of his own.

BLAYDON-ON-TYNE. W. F. DUNTON.

THE SUN AND ITS EFFECT ON VITALITY.

To the Editors of "KNOWLEDGE."

SIRS,—Perhaps the following may be of interest to some of your readers:—

Not long ago Mr. Tillemont Thomson, lecturing at Liverpool, said he believed that there was no heat at all in the sun, and never has been. He supposes the sun to be the source of, or to have stored up in it, an incalculable amount of some kind of energy, and that part of this is transmitted through the ether and when it meets our atmosphere is transformed and produces what we know as heat.

If such be true, then, as there are various kinds of ether waves just as there are various forms of matter in existence, is it not possible that there comes from the sun some other kinds of unknown ether waves which have a direct effect on our vitality? My reasons for supposing such are that, as every one knows, during the early hours of the morning, when the sun is on the other side of the earth, our vitality is at its lowest, and is the time when most people die; moreover, this is *not* due to the effect of the lowered temperature at that time, it is due to something outside all that, because even if these conditions are counteracted for by artificial means, the vitality is lowered still to a certain extent. We know that electricity has an effect on our bodies and nervous systems, and that ether waves affect material substances, so could there not be some ether waves having effect on our vitality?

BIRKENHEAD. C. POTTER.

ANNOUNCEMENTS.

CLASSES IN PHOTOGRAPHY.—We are asked to announce that Mr. Edgar Senior's classes in Photography for the winter session, will open at the following Polytechnics on the dates specified: Battersea, Tuesday, January 9th; South Western, Monday, January 15th and Woolwich, Wednesday, January 10th, 1912.

ILLUMINATING ENGINEERING.—On Friday, January 12th, Mr. J. S. Dow, D.Sc., will begin a course of Lectures dealing with the measurement of light; the comparison of day and artificial light; and practical lighting problems: at the Battersea Polytechnic.

PALAEOBOTANY.—On January 16th, 1912, and on the nine following Tuesdays, at 4 p.m., Miss Marie Stopes, Ph.D., D.Sc., will deliver a series of Lectures in University College, London, on "General and Geological aspects of Palaeobotany." The course is intended for students of Geology, Botany and Mining Engineering, and the fee is one guinea.

ROYAL INSTITUTION.—A General Meeting of the Members of the Royal Institution was held on the 4th instant, Sir James Crichton Browne, Treasurer and Vice-President, in the Chair. Miss Goldsmid, Dr. Habibur Rahman Khan, Dr. W. M. Noott, and Mrs. Middleton Robinson were elected Members. Professor W. C. Brögger (Christiania), Geh. Rath Professor T. Curtius (Berlin), Professor P. A. Guye (Geneva), and Geh. Regiersrung Rath Professor H. Rubens (Berlin), were elected Honorary Members of the Royal Institution. The Chairman announced that the Managers at their Meeting held this day, had appointed Mr. W. Bateson, M.D., F.R.S., Fullerian Professor of Physiology for a term of three years. The following are the Lecture Arrangements at the Royal Institution, before Easter:—Dr. P. Chalmers Mitchell, a Christmas Course of Six Illustrated Lectures on The Childhood of Animals, adapted to a Juvenile Auditory: 1. Introductory; 2. The Duration of Youth; 3. Colours and Patterns of Young Animals; 4. Young Animals at Home; 5. The Feeding of Young Animals; 6. The Play of Young Animals. Mr. W. Bateson, Fullerian Professor of Physiology, R.I., Six Lectures on The Study of Genetics. Professor E. G. Coker, Two Lectures on Optical Determination of Stress and Some Applications to Engineering Problems. Dr. T. Rice Holmes, Three Lectures on Ancient Britain. Professor A. W. Bickerton, Two Lectures on the New Astronomy. Professor A. M. Worthington, Two Experimentally Illustrated Lectures on The Phenomena of Splashes. Mr. M. H. Spielmann, Two Lectures on The Portraiture of Shakespeare. Mr. F. A. Dixey, Two Lectures on Dimorphism in Butterflies: 1. Seasonal Dimorphism; 2. Sexual Dimorphism. The Rev. John Roscoe, Two Lectures on The Banyoro: A Pastoral People of Uganda; 1. The Milk Customs; 2. Birth and Death Customs. Sir Alexander C. Mackenzie, Three Lectures on: 1. The Russian Music of To-day, with the kind assistance of the Hans Wessely Quartet; 2 and 3. Franz Liszt (Centenary) (with Musical Illustrations). Professor Sir J. J. Thomson, Professor of Natural Philosophy, R.I., Six Lectures on Molecular Physics. The Friday Evening Meetings will commence on January 19th, when Professor Sir James Dewar will deliver a Discourse on Heat Problems. Succeeding Discourses will probably be given by Professor Bertram Hopkinson, Dr. J. Mackenzie Davidson, Dr. J. A. Harker, Rt. Hon. Sir John H. A. MacDonald, Mr. G. K. B. Elphinstone, Dr. W. J. S. Lockyer, Mr. F. Soddy, Professor D'Arcy W. Thompson, Professor Sir J. J. Thomson, and other gentlemen.

FIGURE 13.

FIGURE 14.

FIGURE 15.

SNOW CRYSTALS.

By WILSON A. BENTLEY.

CRYSTALS constitute a most interesting and important part of Nature. Their manner and habits of growth are marvellous and full of interest. The seeming similarity of some of their forms and way of growing, to certain of the lower organisms, and to certain vegetal forms, their power of increasing in size and of repairing broken parts, and so on, have almost led some to consider them as constituting the first span bridging the vast gulf existing between the inorganic and organic kingdoms.

However this may be, there is certainly a great difference between plants and flowers, and crystals. Plants and all organic life grow from within outward, and have their forms pre-limited, as they reach a certain size and then cease growth.

Crystals, on the other hand, grow wholly from without, by deposition, and properly never reach maturity, as they are always in a state of incompleteness, and ever ready to resume growth whenever fresh supplies are furnished to them.

Crystals form within saturated gases and chemical solutions and magmas of various kinds, and are usually so situated and surrounded by material as to have equal chances of growing equally in all except basal directions. But they grow mainly, except possibly during their first or microscopic beginnings, in special directions only, thus furnishing proof that certain parts of a growing crystal attract material to themselves in excess of others, and hence have excessive attractive powers for the molecules of matter of which they are constructed. These points of major attraction, when occurring upon the molecules of matter, are called poles; and when occurring upon crystals, axes.

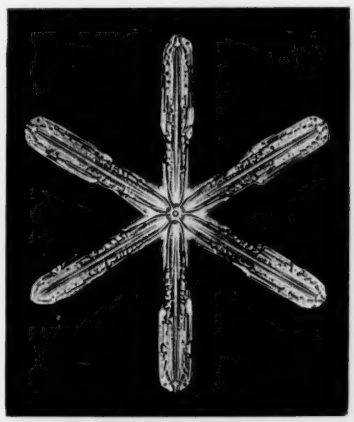


FIGURE 16.

FIGURE 17.

It is assumed that these attractive poles and axes are essentially tiny fixed charges of electricity, and that their number and arrangement is identical as regards the molecules of a given substance, but varies one substance or mineral with another, and that they determine the form and system to which crystals belong. According to this theory, the molecules of water, of which snow crystals are constructed, possess two major and opposite poles, and six (or three) secondary ones. Water, being a diamagnetic substance, presumably tends to arrange itself at right angles to the two main and opposite poles and axes, and hence deposits itself mainly upon and from the secondary poles and axes. Singularly enough, though they grow largely from these polar or axial parts, there are oft-times moments when certain crystals grow in equal or greater degrees from other and intermediate directions, as though new axial points were established upon them. It is assumed in such cases that tiny additional electric charges collect upon the crystals, outside the main axial points, either directly from the indrawn molecules, or through overflow from

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an excess of electricity collecting at the main axial points, and actually do momentarily increase the number of attractive polar or axial points upon them.

It is presumed that crystals, forming within a scantily electrified solvent, acquire excess charges at their axial points, or elsewhere, only at rare intervals, or not at all. Under these conditions but few or no new and secondary axial points would be established upon them. The crystals would, under these conditions, grow mainly from their primary axial directions alone, or from such secondary charges as might collect upon them, and hence in an open rayed, or branching form, or in the shape of long slender spiculae. Crystals forming in a highly electrified solvent would likely acquire many additional charges from the indrawn molecules of the solute, and become completely, or more nearly, charged over their whole exteriors, or at least around their edges, rendering all parts more equally attractive. This would likely cause all parts to grow in a more nearly equal degree, and force the crystals to assume more solid close forms.

FIGURE 18.

Among the more remarkable crystals that occur in nature are those called snow, that form in such vast quantities from the moisture in solution within the gaseous solvent, our atmosphere. Snow must be considered as one of Nature's most wonderful products, viewed in any light; whether for quantity, frequency of occurrence, distribution, place and manner of origin, or for the beauty, complexity, and marvellous symmetry of its crystals. Snow crystals are the only crystals that form (in quantity) from a gaseous solution, *i.e.* from a solute dissolved in a gas (the air).

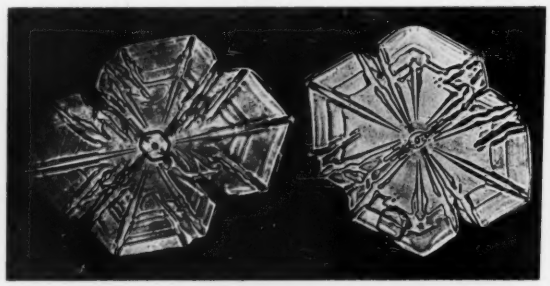

FIGURE 19.

FIGURE 20.

The tenuity of the solvent, air, within which snow forms, far exceeds that of the other liquid and magmatic solvents, wherein crystals form. This extreme tenuity of the solvent allows the molecules of water a wonderful and unapproached freedom of movement and adjustment among themselves while arranging themselves in crystal form, which perhaps partly explains why they so greatly excel others in beauty and perfect symmetry. Snow and ice crystals are perhaps the only ones that form largely while in motion, *i.e.*, while drifting about within the solvent, and hence, in the case of the snow, that develop under constantly shifting conditions of temperatures, viscosities, and so on. They have a habit of crystallizing largely on thin tabular planes, hardly thicker than paper, thus exposing their whole structure to view under the microscope, as though ground into sections for this especial purpose.

These facts, coupled with their common occurrence and accessibility as objects for study, gives them an unique place among their fellows, and an unrivalled value as objects for crystallographic research. It may well be that we shall learn more regarding crystals from a study of them and of their next-of-kin, the frost and ice crystals, than through all other sources.

These considerations, and our great love for Nature-study, led us, while yet in our "teens," to begin a most enthusiastic and comprehensive study of these marvellous crystals. This has been continued ever since, for now over a quarter of a century. During this time we have secured many thousands of photo-micrographs of the various forms of water, snow, frost, ice, dew, and so on—two thousand of snow crystals alone, no two alike.

Our location, Jericho, Vermont, U.S.A., fortunately, was very favourable, as it lies in the path pursued by most of the general storms crossing North America. This doubtless largely explains why the snows of our locality are so very rich in perfect and beautiful snow forms. Winters were found to vary greatly in productivity, some being much more favourable than others.

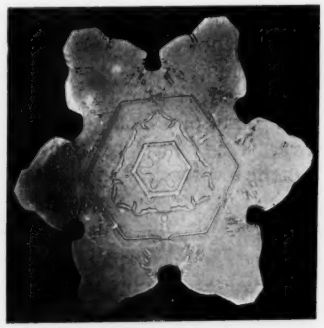

FIGURE 21.

Some winters furnished very few perfect crystals, but in general we were able to secure and photograph from one hundred to two hundred perfect forms each year to add to our collection. It is probable that favourable winters occur in cycles; but more data, covering a longer period, needs to be collected to make this a certainty. Only one storm in about seven, in our locality, furnished

many perfect tabular forms such as we required. It is quite certain, however, that all general storms possess favourable quadrants (the western ones) furnishing perfect tabular forms, their failure to furnish these at any one time or place being due to the fact that their paths fail to bring these productive quadrants over the locality in question.

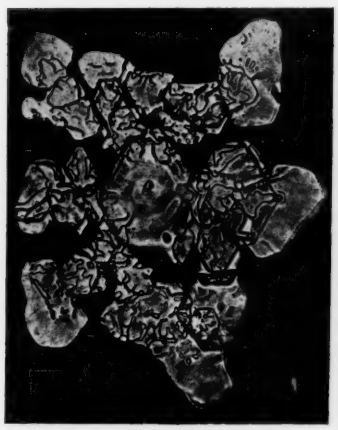

FIGURE 22.

The student of the snow finds much to marvel at in a study of these peerless crystals. What perhaps causes the greatest amazement, is their almost infinite diversity of form and interior. Yet one is almost equally impressed with the almost unbelievable beauty and perfect symmetry of the choicer forms. Among the many remarkable things about them is their habit of very freely enclosing within themselves the solvent (air) wherein they form.

FIGURE 23.

This is doubtless largely due to their frequent habit of constantly changing form and acquiring new branches and adornments as growth progresses, accompanied, in many cases, with progressive solidification. The merging of branch with branch and segment with segment as growth progresses and solidification occurs, accomplishes the bridging over and inclusion of tiny quantities of air, and the formation, in many cases, of a vast number of tiny air tubes and chambers, which add vastly to the beauty and complexity of the internal structure.

The air-tubes possess a further and most fascinating interest, because they outline, in part or whole, transitionary stages of growth, and thus enable us to trace out many of the pre-existing forms of the crystals while growing in cloudland. Another remarkable habit concerns their manner of growth.

The tabular crystals usually grow simultaneously outward, in the form of six-rayed stars, or six-petalled flower-like forms, from a common nucleus. Each of these several parts may, and often does, have but a tiny connection with the others at the nucleus, and hence the whole structure is for all practical purposes, a group of six separately-growing crystals. These rays or segments oft-times undergo a multitude of changes of form, as they momentarily acquire additions here and adornments elsewhere, as growth progresses.

But, marvellous to state, growth proceeds, in most cases, after a common plan, as though at the behest of some central controlling influence. A branch or other adornment forming at any given moment and point upon one of the rays or segments, is often instantly and exactly duplicated, as regards time, form, location, and so on, upon all the others, so that perfect symmetry is always maintained.

More marvellous still, growth usually proceeds a little differently in individual cases, so that it is rarely the case that any two are just alike when completed.

A further study and analysis of the forms and habits of growth of these marvellous snow crystals as revealed in the photo-micrographs, and directly under the microscope, discloses much of great interest.

One fact relates to the characteristic manner of formation of the main and secondary rays of the six-rayed starry forms. The secondary rays occur, in general, in pairs, and directly opposite each other upon the main rays. But, strange to say, exceptions are not rare, for we occasionally find secondary rays without corresponding mates on the opposite side of the main ray. It adds much to the interest of these exceptional cases that their frequency increases with distance from the nucleus.

Another interesting thing is the way the secondary rays behave toward each other whenever they grow so far outward as to meet. In most cases, if the rays are short, as when they spring outward and meet close to the nucleus, the tips merely merge, and growth ceases thereafter, in the manner adopted by the first set of branches as shown in Figure 13.

But oft-times in cases in which the secondary rays form far outward from the nucleus, a seeming crossing of the secondary

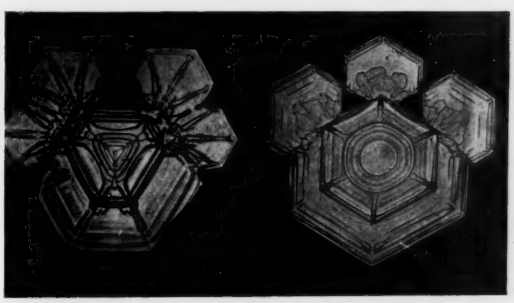

FIGURE 24.

rays takes place, after which each continues growth in the original direction, as shown in Figure 15.

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More rarely, such a meeting causes the secondary rays to undergo deflection, and to grow thereafter in entirely new directions, as so interestingly shown in Figure 14.

In rare cases, such a meeting may even cause curvilinear deflection.

Especially mysterious and interesting are those cases in which secondary rays fail to form along the primary rays, so beautifully shown in Figure 16.

The mystery is heightened, because in most cases, and even in this, a close inspection of the edges of the primary rays shows that primitive secondary rays formed along the primary ones, but were subsequently either encased in solid layer growth, or failed to increase appreciably. Another mystery concerns the occasional habit some of the secondary rays have, of growing downward or inward, instead of in the usual outward manner. This drooping habit is exquisitely shown in Figure 13.

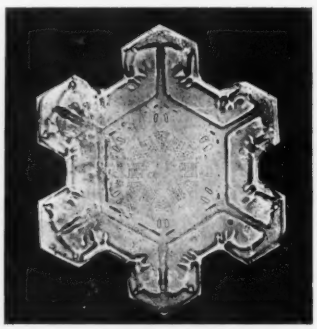


FIGURE 25.

More puzzling still are those crystals in which, for no apparent reason, secondary rays form only in alternate order, and upon only three of the main rays, producing a trigonal effect so graphically pictured in Figure 17. Odd freak crystals, due in some cases to accident, in others seemingly to design, are not uncommon among the snows of some general storms.

Those of a trigonal shape, Figure 18, those exhibiting a tendency to divide into four or eight, and the odd three or four vaned crystals, and some others, belong in this category. Those having four segments are shown in Figure 19. The most strange and rare freaks are, perhaps, those that undergo a change of type from trigonal to hexagonal, or hexagonal to trigonal, as growth progresses, as shown in our Figures 20 and 21.

Among the more strange freak tabular crystals are those of chaotic design. Figure 22 is a case in point, in which the several parts are not only unlike and of unequal sizes, but are also attached in irregular order around a central, and irregular, nucleus. Crystals of this character seem to form most frequently within eastern storm segments, when tabular crystals first appear among columnar ones, preliminary to a complete or partial change of type to the former.

Possibly the most singular type due to design, is the compound "cuff button type" (Figure 23), due to tabular outgrowths occurring from the ends, and, more rarely, sides, of columnar crystals.

Doubtless in many, perhaps all, such cases, the columnar part formed first at high and cold altitudes, and the tabular parts later, at some lower cloud level.

Among the more puzzling forms are those exhibiting binate symmetry, and in which one-half or two-thirds of a crystal differs from the other portion, as in Figure 24. The crystals possess such an amazing richness and complexity of interior that scant mention of these features can be made in a single article.

Perhaps the most wonderful and inexplicable of these interior features are the tiny sets of clustered microscopic air bubbles which some few of them possess. These usually encircle the nucleus, and are arranged, in some cases, in a symmetrical order perfect almost beyond belief, as shown in Figure 25.

Accidental causes produce many freak crystals. Crystallization often occurs while the crystals are crowded close together, or lie partly embedded in a cluster, so that some parts have free, while others have scant, opportunity of growing. Crystallization, moreover, often occurs upon fractured crystals, upon broken parts, all of which causes tend to produce irregular forms, oblong crystals, and so on.

The latter are oft-times especially interesting, as they show very beautifully the attempt of the crystallizing forces to build up symmetrical structures around imperfect nucleii.

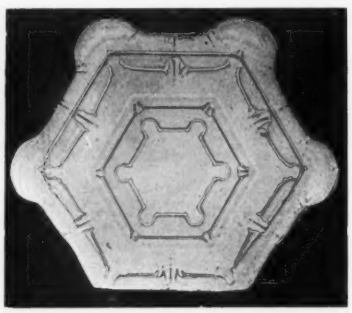


FIGURE 26.

Very interesting are those cases in which two or more crystals grew, in part, while lying close together. The closely lying parts having, of course, less material available and supplied them than the outlying ones, necessarily grow in a stunted manner. In many cases, branches or other adornments acquired elsewhere, failed to form thereon, causing a break in the continuity of the design.

In many cases, however, the crystals seem to attempt to reproduce the general pattern clear around, even though supplied with insufficient material at some points, and do so to the degree that the design, though thinner and smaller, is yet kept, in part at least, intact, as shown in Figure 26. The more perfect crystals of snow are doubtless the most perfect and beautiful examples of Nature's inorganic art and of symmetrical design occurring in Nature. Their value, whether in an educational way as objects for nature and crystallographic study, or in the realm of art, as models for designs in jewellery, metal, wall paper, lace, china, silk goods, and so on, should be very great, and has led already to their being extensively used by universities, museums, schools, lecturers, art craft shops, designers, and so on.

There will doubtless be a great increase, in the future, in the uses to which they will be put, as these bits of pure beauty from the skies become more generally known and more fully appreciated.

SNAKES, BURRS AND BIRDS.

By CUTHBERT CHRISTY, M.B., F.Z.S.

WHILST exploring one of the big forests in Uganda in 1907, I one day told my men that I wanted some puff-adders, two species of which (*Bitis nasicornis*) (see Figure 27), and a much larger one (*Bitis gabonica*), are very common in these forests. Next day I had three or four brought to me, and the following day several more. My intention was to collect a quantity of the venom, and ultimately preserve the skins.

From a photograph by W. S. Berridge, F.Z.S.

FIGURE 27. The Rhinoceros Viper* (*Bitis nasicornis*).

These dangerous snakes are fortunately sluggish brutes, very unlike most of the Indian ones. The largest species, which is sometimes five feet long, is usually found curled up amongst the dead leaves on the ground, where it may, apparently, remain for weeks without moving. I have seen a hundred men in line tread within a foot of one without its taking any notice. Both species have the the power of puffing themselves out, when irritated, to more than double their usual girth, and can strike with tremendous force. The smaller and horned one is more often found amongst the undergrowth, a considerable distance from the ground.

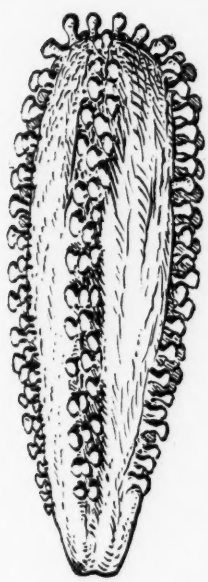


FIGURE 28.
A Burr of *Pisonia aculeata*.
Its length is twelve millimeters.

The facility with which my men procured a number of these poisonous vipers surprised me. On questioning them one said something I could not understand about "birds in the grass"; so next day I went with him into the forest, telling him to take me to where he had found the snakes he had brought. On reaching the place, he pointed out some clusters of a small climbing plant† a few feet off the ground, and not unlike the common woodbine of our hedgerows. On closer examination, I found that the withered parts of this plant bore hundreds of small fruits or "burrs" (see Figure 28), which clung to my coat sleeve and almost anything that touched them ever so lightly. I was still unable to imagine what possible connection there could be between this plant or its fruits and the snakes: but sure enough we found two puff-adders, and saw other snakes beneath this mystifying plant, although to see a snake in the African forests is not such a very common occurrence.

On returning to camp and going into the matter with an interpreter, I was forced to the conclusion that the plant was able to catch small birds, or at least to so hamper their movements if its "burrs" became entangled in their feathers that they fluttered about on the ground and became an easy prey to the snakes lying in wait beneath, though it seemed crediting the reptiles with extraordinary perspicacity or even some amount of botanical knowledge.

Some months after this, one of my European assistants brought me a bird about the size of a sparrow which he asserted he had caught in the forest with his hands, and which had its wing and body feathers so matted and tangled with these very same "burrs" that it could do no more than flutter about the floor. So that it must be really a fact that these snakes have sufficient intelligence to distinguish in some way either the plant or the locality in which it grows, or else have learnt by experience that that precise spot is one in which small birds, so hampered in their movements that they are unable to fly away, are likely to be found. In Africa the forest natives are full of little items of observation, such as this, that delight the field-naturalist.

FIGURE 29.
A section of the Burr showing the knobs with which it is provided.

* Mr. Raymond Ditmars, author of "Reptiles of the World," says on page 327 of his book that the Rhinoceros Viper is the most beautifully coloured of all snakes. This is his description of a specimen which has recently cast its skin:—

"Entire upper surface presenting the effect of variegated velvet. A row of pale blue, nicked, oblong blotches on the back, each longitudinally traversed by an orange yellow band and narrowly bordered with the same hue. The blue oblongs are set in jet black rhombs and these in turn are bordered with dark carmine. Sides, with large, upright, ruddy-brown triangles, bordered with dull carmine, thence with black and externally with pale blue. Between all of the blotches and pronounced markings, the ground color is rich olive, thickly peppered with black. The head is bluish, with black dots, and ornamented in the centre with a sooty-black arrow-shaped blotch pointing forward; the horns are yellow." (EDS.)

† Dr. Otto Staps has kindly identified it as *Pisonia aculeata* (Order Nyctaginaceae).

PROFESSOR A. W. BICKERTON.

IN the belief that many readers of "KNOWLEDGE" who have studied the recent articles on "The New Astronomy," by Professor A. W. Bickerton, would like to know something about the career of this capable expounder of a new theory of the universe, the few following facts have been collected. They will explain how it happens that the originator of such an epoch-making discovery has remained almost unknown in British scientific circles, whereas had his life-work lain in the home country his name would have been familiar in our mouths as household words.

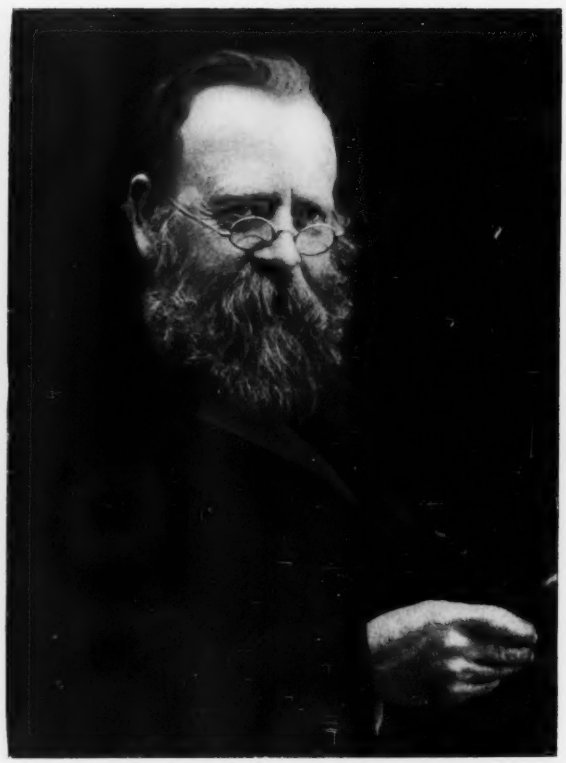


FIGURE 30. Professor A. W. Bickerton.

Alexander William Bickerton comes of an old Cheshire stock and was born at Alton, Hampshire, in 1842. Draughtsmanship is a characteristic of his family; his father at the age of fourteen won the silver palette of the Society of Arts, and later practised as an architectural draughtsman; while a son of Professor Bickerton is an artist.

Educated at Alton Grammar School and intended for a civil engineer, Bickerton entered the Bridgwater Carriage Works of the Bristol and Exeter Railway. Inventiveness soon appeared and in 1864, having devised some machinery for wood-carving, he secured a mill in Painswick, Gloucestershire, in which to develop his ideas. At this time some science classes were being started in the neighbouring town of Stroud and young Bickerton attended these, at the end of the session gaining a first class and the national bronze medal in the Science and Art examination. Being attracted to a scientific career by the enthusiasm of the teacher, he applied himself more closely, and the following year gained further successes in magnetism, electricity, and animal and vegetable physiology. In 1866 he migrated to Birmingham, and while studying for his science teacher's certificate organised and taught in evening technical classes in that city. His workshop experience enabled him to attract artisans to his classes and they became most successful. At this time the regulations of the Royal School of Mines were altered and the examinations that enabled a teacher to obtain the teaching certificate also qualified him for an exhibition at the School of Mines. These regulations were only published thirteen weeks before the examination in 1867, yet purely by private study Bickerton was able not only to pass, but also to secure a Royal Exhibition, and that in a year when the competition was unusually severe. He won three national medals and seventeen Queen's prizes, of which six were first prizes, in various subjects. For the next three years he studied at the Royal School of Mines and the Royal College of Chemistry and utilised his evenings in organising evening technical classes in London. He was actually the first science teacher under the Science and Art Department who succeeded in London after some scores had attempted and failed. It was his classes that originated the gigantic technical educational scheme among the London working classes, and in 1870 Sir Henry Cole, before the Royal Commission on Scientific Education, spoke of him as "a great organiser." In the same year an incident is related by Sir George C. T. Bartley, Bart, in *The Journal of the Society of Arts*, that accounts in some degree for the phenomenal success of these classes through the enthusiasm engendered in the students by Mr. Bickerton. A school was started in Arthur Street, Chelsea, and the premises proving inadequate, others were taken in College Street. These consisted of a disused carriage factory, and funds to fit them for a regular science school being lacking, the students themselves undertook the whole labour of building a lecture amphitheatre with smaller class rooms under part of the raised seats. Carpenters, gasfitters, whitewashers, and other artisans came night after night from six o'clock to eleven and even later. The task took six weeks, and so anxious were the workers to finish it and to resume their classes under Mr. Bickerton that they could hardly be got away each

evening until the plan of lowering the gas proved effectual.

Under the chairmanship of the late Sir Charles Dilke, these classes rapidly secured upwards of a thousand students, and became the largest and most successful in the kingdom ; while, in spite of this heavy extraneous work, Mr. Bickerton was attaining unique success at the Royal School of Mines. At the end of his first year he won the Senior Royal Scholarship, with 100% of marks in four subjects, and an aggregate of 98% in all—this against such competitors as Professor Sollas, Principal Garnett and Professor Liversidge. Completing his course at the Royal School of Mines and the Royal College of Chemistry he obtained the highest class in all save one subject. Many good offers followed, and he took charge of the science work at the Hartley Institute, Southampton, and also taught at Winchester College and the Training College, and was appointed analyst to the Borough of Southampton, and also to the main division of Hampshire. When Cooper's Hill College was established, the Indian students, who were the mainstay of the Hartley Institute, migrated thither, and Mr. Bickerton, becoming dissatisfied with the unsettled state of the Institute, received offers of many posts, among them being the Professorship of Chemistry at Christchurch (Canterbury College, University of New Zealand).

This offering a more unrestricted and broader field, more leisure and opportunities for original research, Mr. Bickerton finally accepted, the authorities consenting to all the conditions formulated by him as requisite before his acceptance. Accordingly he went there in 1874, and there he worked until 1902, teaching chemistry, electricity and physics, acting as Government analyst, and incidentally giving many public lectures, both technical and popular. His researches have resulted in great pecuniary advantages to the Dominion's industries in many directions.

It was the appearance of Nova Cygni in 1877 that first strongly directed Professor Bickerton's attention to astronomy and particularly to the stupendous nature of temporary stars. From this attention the theory of partial impact and the formation of the third body, so lucidly explained by Professor Bickerton in his articles in "KNOWLEDGE," was evolved.

FIGURE 31. Professor Bickerton's Home, Wainoni Park, Christchurch, New Zealand.

Although the formulation of the salient features of the theory, or rather induction, took but a short time, it was some years before the magnitude of the discovery became apparent to its originator, and as its truth was tested in relation to other celestial phenomena than novae it gradually dawned upon him that he had discovered what has been justly called "the master-key to the Cosmos."

His advocacy, however, of this theory outside the College, gave great offence to a certain section of the Board of Governors, and in 1894 and again in 1899 attempts were made to oust him from his position. The first failed lamentably, as at the enquiry it was proved that his students gained more scholarships than all the rest of the colony together and the

Honours successes in physical science among his students were more than seven times as numerous on an average as those of any other professor in New Zealand. The second attack was more successful, as he was practically given the option of resigning either his theory or his professorial chair. Professor Bickerton valued his post less than his theory, so after some years his connexion with the University was severed and he was able to devote his time, untrammelled, to research. Some eight years afterwards his choice was justified. At the suggestion of Earl Dudley, then Governor-General of Australia, a fund was started; the Board of the very University that had insisted on his resignation took up the project, and the New Zealand Government contributed half the total sum. Thus subsidised, Professor Bickerton was enabled to come to England to lay his theory clearly before the scientific world, in the confident hope of securing its general acceptance.

Professor Bickerton's object may be briefly stated as follows:—

To explain his theory of Partial Impact and the formation of the Third Body and the many extraordinary properties it possesses, and to show that cosmic impact is not an accidental and destructive occurrence, but a law of nature brought about by a great number of agencies, and that it is the most powerful constructive factor in the whole scheme of creation. We believe that all who have carefully read Professor Bickerton's four articles will agree that he has made out a very strong case and that this theory deserves the closest and most sympathetic attention from all astronomers, professional and amateur.

A NATURE CALENDAR BY GILBERT WHITE.

By HUBERT H. POOLE.

GILBERT WHITE, of Selborne, can need no introduction to readers of "KNOWLEDGE," for many of us obtained our earliest natural history impressions from the fascinating pages of that old-time but perennially interesting volume "The Natural History of Selborne."

Gilbert White kept very full records of his observations for over forty years, and his diaries (which have been preserved) begin in 1751 and continue until his death in 1793. For the first thirteen years they are mainly concerned with gardening operations and contain but few notes on wild nature. In 1765, however, a change occurs. White in that year bought a copy of Hudson's "Flora Anglica," beginning in earnest the study of botany, and his notes reflect this new interest: but his ordinary diary for 1766 contains naught but garden observations, all his natural history notes during that year being reserved for a special and unique compilation — the Nature Calendar with which we are now concerned.

The Selborne Society has just published, in facsimile, a reproduction of this interesting work, which is edited by Mr. Wilfred Mark Webb, F.L.S.

In the Introduction it is shown that this record was most probably compiled to form a basis for the "Annus Historico-naturalis" mentioned in White's last letter to Daines Barrington. On the back of the title-page of the manuscript it is called "Flora Selborniensis: with some co-incidences of the coming, and departure of birds of passage, and insects; and the appearing of Reptiles: for the Year 1766." It also contains a number of interesting weather records. From this it will be seen that the work was not intended to deal with plants alone, but forms an exceedingly interesting general Nature Calendar.

The total number of species of plants that White recorded as occurring in the parish of Selborne is four hundred and thirty-nine. In this Calendar for 1766 over four hundred are detailed—a very noteworthy list for one year. Very few records are secondhand, perhaps half-a-dozen; all the rest are the personal observations of the famous naturalist.

An entry for July 2nd is of considerable ornithological interest. It runs "Caught, and ascertain'd the *Regulus non cristatus*. It is a very small bird, but bigger than the golden-crowned wren; pretty common and very mischievous among pease and cherries."

It is well known that White differentiated the Chiff-chaff, Willow-warbler and Wood-warbler which, until his day, had all been lumped together under the name of Willow Wren. This date probably marks his first record of *Phylloscopus* and two years later, August 17th, 1768, he enumerated the three species in a letter to Pennant.

The wrongful accusation that the Willow-warbler is a frugivore, which he reiterated in Letter XVI to Pennant, April 18th, 1768, is a curious error for such a keen observer as Gilbert White to make. The three *Phylloscopi* are now considered to be entirely insectivorous. Harting, however, has suggested that White may have mistaken the young of garden-warblers—which do at times eat fruit, and, as a species, were unknown to White—for willow warblers.

In the ample Index much research has been devoted to the task of supplying the modern scientific names to the plants, birds, insects, and so on, recorded by Gilbert White; but a few still require identification.

One example of these interesting lacunae is to be found on page 58 which we are able to reproduce herewith. No. 272 of Ray's "Historia Insectorum" is doubtless *Eristalis tenax*, but No. 271 is so far unidentified. (See Plate I.)

58. Octob^{r} 17. Black cluster-grapes are delicate.
Common snake, natrix torquata, still appears.
The blind-worm, or slow-worm, Caecilia, is seen.
Catkins of the alder, alnus, are formed:
The cones are full of seed.
Musca apiformis, tota fusca, caudâ obtusâ, ex
culâ caudatâ in latrinis degente orta, still is
seen. This fly frequents sinks, & jakes, where it
lays it's eggs. In the autumn it feeds on the flowers
of late annuals, & perennials; & in particular
on the blossoms of Ivy. Ray hist: Insect: 272.
Musca bipennis major, diversicolor, caudâ setis
nigris obsitâ [redacted] appears, & engenders. This
fly is entirely a garden or field-fly. never entring
into houses: it appears to feed on mellow fruit.
M^{r} Ray seems not to have been aware that it
smells strongly of musk: it might therefore not
improperly be call'd musca moschata. 271.
This seems to be an autumn fly altogether.
20. Common wild service-tree, or Sorb, Mespi-
lus apii folio sylvestris non spinosa, seu Sorbus
torminalis, in fruit; but it is hard, & austere still.
21. Wheat springs out of the Ground.
22. The fieldfare, turdus pilaris, returns.

Page 58 of Gilbert White's Nature Calendar for the year 1766.

THE MILKY WAY.

By Rev. T. E. ESPIN, M.A., F.R.A.S.

In the years from 1891 to 1893 a valuable series of papers were published in "Knowledge" by M. Ranyard, some being contributions of his own, on "The Structure of the Milky Way," others by Messrs. Maunder, Wesley and Sutton; while letters appeared from Professor Barnard and others. The articles were illustrated by photographs of "The Milky Way," taken by Professor Max Wolf, Professor Barnard, and in the South by Mr. Russel. The general result seemed to be that the theories of the past—such as may be summed up as the Cloven Disc theory of Wright, Herschel, Struve, the Spiral Theory of Proctor, or the Double Ring Theory—all failed to explain the phenomena presented by the photographs.

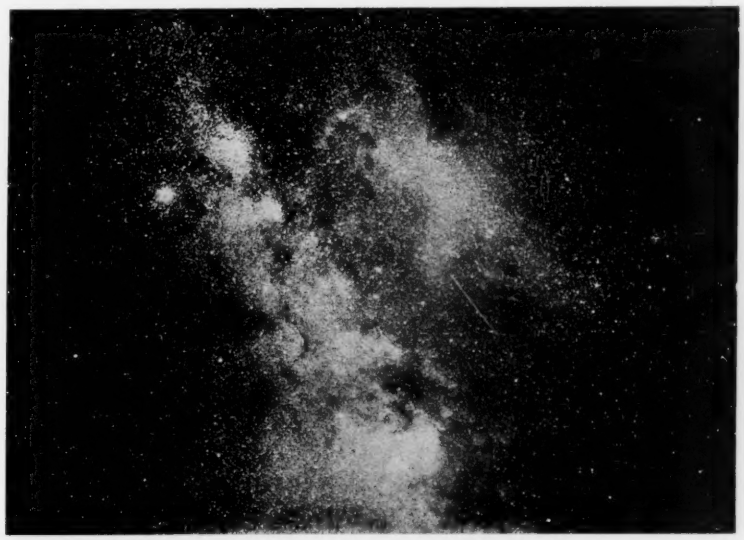


Figure 32. Aquila.

Twenty years have now passed, and during that time many fresh photographs, with various apertures, have been obtained. Professor Wolf has published a complete series of the Milky Way, as visible at Heidelberg, made with a small wide-angled lens, in "Die Milchstrasse," and a great

Figure 33. Cygnus.

mass of fresh material has accumulated from the photographic researches at Harvard College, and at the Harvard Station of Arequipa. The photo-telescopes of eight-inch and twenty-four-inch aperture, fitted with objective prisms, have been diligently used, and the examinations of the plates by the late Mrs. Fleming have revealed the fact that certain classes of heavenly bodies are found almost without exception in or near the Milky Way. The stars of Type V, the Gaseous Nebulae, the Orion stars with bright lines, the Temporary stars, all tend to arrange themselves in positions of small Galactic latitude. On the other hand, as is well known, "white" nebulae and globular clusters avoid the Milky Way. The stars of Type V show, above all others, not only an affinity for the Galaxy, but for the apparent centre of it. In 1891 our knowledge of the stars of Type V was extremely meagre; there were the original Wolf-Rayet stars in a group in Cygnus; subsequently others were swept up with the spectroscope by Copeland and Pickering. An examination of the photographic plates taken at Harvard and Arequipa have revealed a large number of new ones, and it seems

quite certain that all the brighter members have now been discovered, though fainter ones from time to time are detected. Now, if the stars of type V are plotted down, it is found that they coincide in a remarkable manner with the central circle of the Milky Way; so much so, indeed, is this the case that the circle is clearly marked

FIGURE 34. Sagitta.

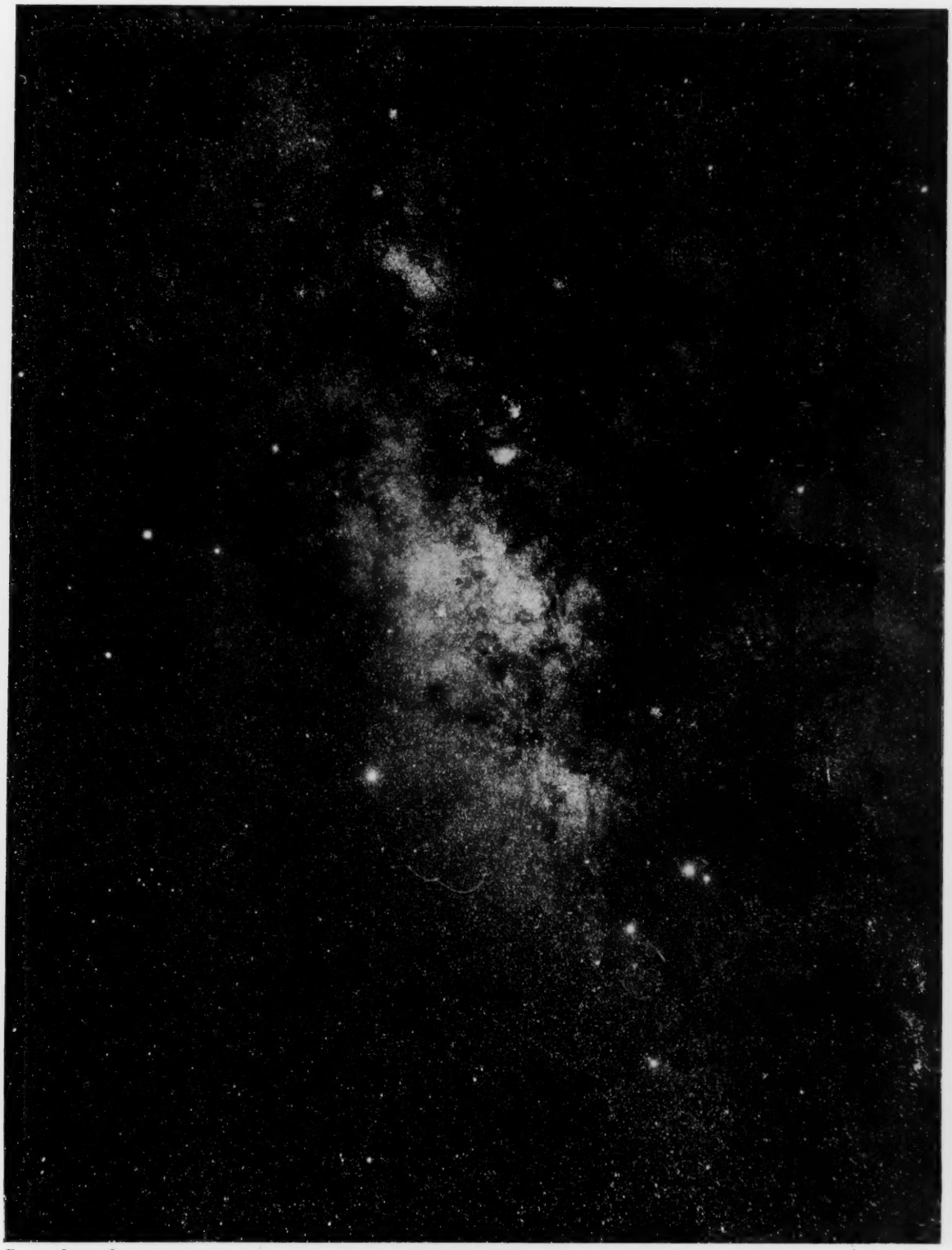
out by them when they are sufficiently numerous, and even where the great bifurcation takes place, these objects persistently follow the centre. The average deviation of the whole number is probably less than two degrees. As Miss Clarke has very truly said, we must believe that the Milky Way is very much as we see it, and that it is not to be explained by two intersecting rings or by spirals. The V-type stars may then be deemed to mark the absolute equator of the Universe of stars. Now in the Southern Hemisphere, near the poles, and quite separated from all apparent connection with the Milky Way, are two cloud-like masses called the Nubecula Major and Minor. Herschel, after examining the Nubecula Major, was clearly of opinion that it was a *multum in parvo* of the visible universe. Here, in the space of a few degrees, are found stars, irregular and globular clusters, nebulae planetary and irregular, all commingled in inextricable confusion. Photographs of the spectra of the objects therein contained, made with the twenty-four-inch Bruce telescope, have confirmed Herschel's dictum by revealing twenty stars of Type V, fifteen objects showing the spectra of gaseous nebulae, and eight Orion stars with bright lines.—Comparisons of the plates have further revealed eight hundred and eight variable stars !—But these new facts may give us a clue by which the seeming inextricable confusion may be reduced to some sort of apparent order. If the objects showing bright lines are charted, several facts are immediately obvious. There are first of all distinct groupings, the most remarkable being that connected with the great nebula, 30 Doradûs. In this group, in a circle of one degree, there are six stars of Type V, three gaseous nebulae including 30 Doradûs, and five bright line Orion stars. In the same way the position of N.G.C. 1763 is marked by three stars of Type V, and four gaseous nebulae. Now, if the Nubecula Major really is a miniature universe, there is a strong probability that the stars of Type V mark its equator. Obviously if the Nubecula was situated at right angles to the line of sight, the stars of Type V would tend to arrange themselves in a circle; if, on the other hand, it was inclined to the line of sight, the form would be an ellipse, the eccentricity varying with the inclination. To test this, a chart was made of the Nubecula and affixed to a wall, and illuminated by a light placed some twelve feet away; then between the two was placed a circle of cardboard mounted on a tall stand, and movable round an axis. Repeated trials showed that it was possible to draw an ellipse, with the following

FIGURE 35. Perseus.

results for stars of Type V:—

Total number	20
Near ellipse	14
Inside	3
Outside	3

The ellipse was then roughly marked on the



From a photograph The Milky Way. *by S. I. Bailey.*

The exposure was made with a Cooke Lens of about one inch aperture at Arequipa and lasted for 24 hours.

By the courtesy of Professor E. C. Pickering, of Harvard College Observatory.

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chart and the following elements obtained:—

Semi-major Axis	2° 35′
Position Angle	312°
Eccentricity	0·84
Inclination	33°

The pole of the Nubecula points almost exactly at δ Doradûs, and there is apparently a condensation of nebulous objects at the poles. In the Nubecular Minor only one V-type star has been found, but the general appearance suggests a similar construction to the Nubecular Major, with a position angle of about 40°. It is obvious that the mixing up of Galactic and non-Galactic objects must take place as observed by Herschel if the poles of these spheres are inclined to the line of sight. For instance, a V-type star and a "white" nebula may be in the same field, the V-type star being on the equator, while the white nebula is on the opposite side of the sphere, and consequently situated at a distance from the equator.

Having examined this Universe in miniature we may now go on to apply its lessons to the Milky Way. We take a sheet of paper and divide it into squares, and along the top write the hours of Right Ascension, and down the sides the Declinations. Next we lay down the path of the Milky Way according to Gould; then having made a collection of all the known Galactic objects, viz.—Type V stars, gaseous nebulae, Orion stars with bright lines, temporary stars, we insert them in their proper places. Immediately it is obvious that the V type stars tend to collect in groups, the two largest groups are in proximity to η Argus and P Cygni, both of which stars have bright lines and have undergone remarkable fluctuations in light. η Argus is associated with a remarkable nebula, and Professor Max Wolf finds vast nebulous patches in the Cygnus region. Further, these places approximately coincide with each end of the great bifurcation of the Milky Way. A glance at our chart shows us also that the V-type stars are much more plentiful in the region between Argo and Cygnus than elsewhere, and further that they tend to follow the medial line, and are grouped upon it at intervals. The gaseous planetary nebulae follow the same law, save that they are more widely distributed, and prefer the following rather than the preceding of the two Galactic streams. The distribution of the Orion stars with bright lines points to the same fact though in a less marked manner, while the temporary stars are more evenly distributed. Taking the percentages of each of these groups we obtain the following table:—

Milky Way.	Type V.	Plan. Neb.	Orion Stars.	Temporary Stars.
Medial circle ...	78·8	5·4	15·8	25·0
Preceding stream	0	26·8	28·9	40·0
Following stream	21·2	67·8	55·3	35·0

If we examine the region from Argo to Cygnus we find in each case the tendency is rather to groups than to uniform distribution. Passing from the great Argo group at Galactic longitude of 255° a group of V-type stars occurs at longitude 275°, a second at 320°. At this spot the planetary nebulae, so far scarce, begin to collect on the following stream of the Galaxy, coming to a maximum at longitude 340°, and here in turn begin the more scattered temporary stars extending up to longitude 360°. The planetary nebulae still continue plentiful up to longitude 30°, then there is apparently a gap till the P Cygni region is reached. Beyond this the Galaxy is singularly poor in bright line objects, and the stars of type V, so far as they are at present detected, disappear altogether between longitude 110° and 190°. Before the latter degree is reached the Orion stars with bright lines begin to appear, and soon become numerous, lying persistently South of Milky Way central line. One group seems connected remotely with the Orion nebula, and a second is found amongst the bright stars which mark the Southern limit of Canis Major. The following table shows in a striking manner the difference between the Argo-Cygnus region and the remaining 213 degrees of Galactic longitude:—

PERCENTAGES.

	Degrees.	Type V.	Temporary Stars.	Plan. Neb.	Orion Stars.
Argo-Cygnus ...	40·8	81·7	70·8	66·7	55·9
Rest of Galaxy ...	59·2	18·3	29·2	33·3	44·1

Whatever inference we may draw from these results must be carefully guarded with the proviso that it is correct only *as far as our knowledge at present extends.* Some thirty years ago the V-type stars were confined to the Cygnus group; to-day the vast majority are found to extend between η Argûs and P Cygni; but at any rate we seem warranted in drawing the conclusion that in the case of the brighter members in each group of Galactic objects, the ratios of distribution are fairly complete. With increased telescopic power the gaps may be filled up; but it will be with objects fainter than those at present known, and one or two alternations will present themselves, either the causes which produce V-type stars, and so on, are less active in one direction than another, or we are decidedly nearer one section of the Galaxy than we are to the other. At present the general consensus of opinion seems to be in favour of the latter alternative.

Our illustrations show in the large plate the Milky Way from ten degrees to fifty degrees south of the Equator, and the four smaller ones (taken by Professor Wolf with a small lens, and reproduced by his courtesy), carry us north as far as Perseus. Thus they cover the whole of the bifurcation, which, it will be seen, is much more obvious to the naked eye than on the photographic plate. Throughout there will be noticed semicircular dark spaces, probably of absorption matter.

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HARMONOGRAPH TRACINGS RECORDED ELECTROLYTICALLY.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc., AND C. W. JUDE, B.Sc.

London County Council Paddington Technical Institute.

ANY form of harmonograph may be used in these experiments. The ordinary tubular writing pen is replaced by a steel needle with its point carefully blunted on a hone so as to have a smooth semi-circular end. This end forms one of the electrodes. The other electrode is a sheet of brass which is fixed firmly to the writing table of the instrument. The electrolyte is a solution of ammonium nitrate and potassium ferro-cyanide in water. The paper upon which the record is to be taken, is soaked in this solution and is then partially dried. The needle is insulated from the harmonograph by being thrust through a cork which fits the holder designed to receive the ordinary tubular pen; it is connected by a very thin wire to one terminal of the source of electric current, while the brass plate upon which the prepared paper is placed is similarly connected to the other terminal.

If direct current is employed an electromotive force of about twenty volts will be found suitable, though this will depend on the kind of paper used, and other circumstances. The provision of a rheostat for regulating the current will be found convenient. When the needle is safely started describing its path on the paper the current is turned on, and is switched off after any desired stage of progress of the record has been attained. By interrupting the current by a clock signal the period of vibration of either pendulum can be determined, or if these periods be known an interrupted trace will serve the purpose of a chronograph record. The direction in which the trace is made by the style can also be recorded by this method. For example, a short interruption followed by a longer one would serve the purpose of an arrow-head on the trace and would indicate the relative direction of motion of the style and paper.

If alternating current is available, pictures like those in the accompanying plate may readily be produced. In this case, the current being reversed many times a second, the electricity is flowing in the direction required to leave a trace, only for a small fraction of a second at a time. The trace then is built up of a series of more or less elongated dots, the intensity of each being greatest in the middle, and shading off to nothing at each end. The number of the dots marked per second is nearly constant, and is equal to the frequency of the alternating supply. It follows from this that the dots are spaced on the trace so as to show by their remoteness or proximity to each other the quickness or slowness of the relative motion of the needle and paper. The velocity of the style with respect to the paper is given in centimetres a second by dividing the frequency of the supply by the number of dots in a centimetre. It will be found that an effective voltage of about forty is suitable for use with paper of the thickness and quality of good unlined foolscap; but again it will be an advantage to have means of varying the voltage so as to obtain the best effects.

As with ordinary harmonograph curves, the more simple ratios of period give the best pictures. Figures i–v are all given by the ratio 2 : 1, the tuning being accurate in Figures iv and v. Figures vi–ix are given by the ratio 1 : 1, the only figure of these in which unison is exact being Figure vi. The initial phase is maintained throughout the diagram in Figures i, iii, iv, v and vi, this being very accurately so in Figures iv, v and vi. In Figure ii, however, the phase difference of the two pendulums is originally similar to that of Figure iv, and finally is like that of Figure i. Figure vi is the only diagram in which the dots are equally spaced throughout one complete oscillation of both pendulums. The velocity in each turn of the spiral is practically constant, but decreases as we approach the centre of the figure. In Figures vii, viii and ix we commence with an approximately circular path, but owing to unequal damping of the two motions, and to change of phase-difference due to inaccurate tuning, the final curve is a much flattened ellipse of different orientation from the original one.

In Figures i and iii it will be seen that the trace was stopped when the left to right motion had almost died away, while the up and down motion was nearly as vigorous as at first. This effect, which may, of course, be shown with any harmonograph, whether the printing be electrolytic or otherwise, can be produced either by using pendulums with bobs of very unequal weight, or by damping the motion of one by means of a flat flexible spring rubbing lightly against the rod of the pendulum so as to press on the rod in a direction at right angles to its motion.

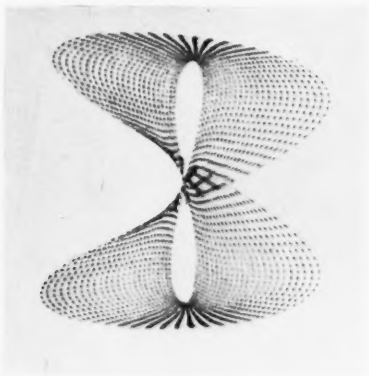

FIGURE i.

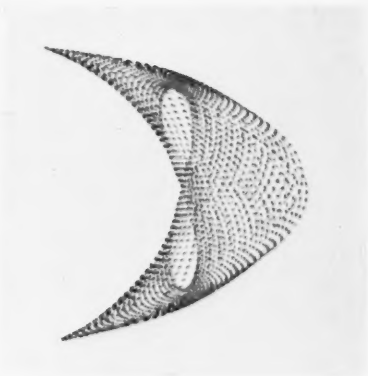

FIGURE ii.

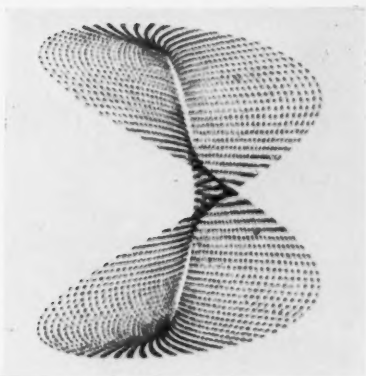

FIGURE iii.

FIGURE iv.

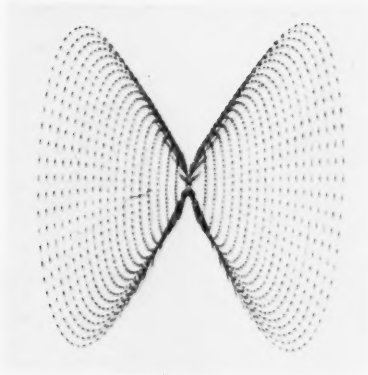

FIGURE v.

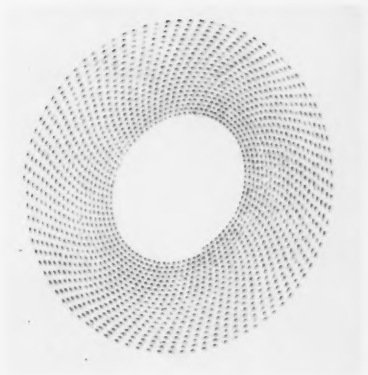

FIGURE vi.

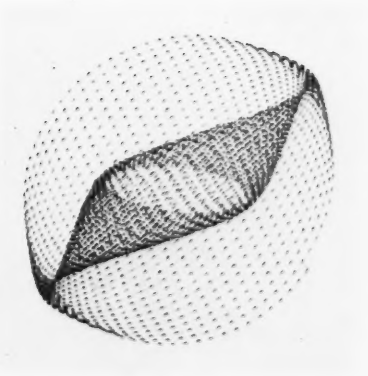

FIGURE vii.

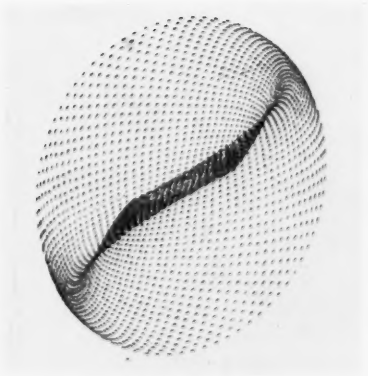

FIGURE viii.

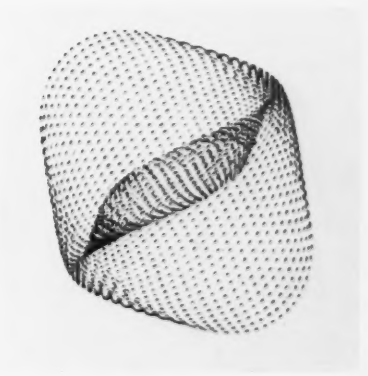

FIGURE ix.

Harmonograph tracings which have been recorded Electrolytically.

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QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed here.

QUESTIONS.

1. ASTRONOMY.—In Sir R. Ball's "Elements of Astronomy," page 366, *re* astronomical constants, a number of quotations are given as to the co-efficients of aberration: the three largest values are those of C. A. F. Peters, 1844, 20″·503: Newcomb, 1895, 20″·511: Maclear, 1850, 20″·530. Have any recent calculations been made giving larger values? In observations regarding aberration so much depends on the allowance made for refraction, even when stars near the zenith are selected, that it is not surprising that Sir R. Ball gives twelve different quotations as to the values. I may observe that a value slightly under 20″·630 would agree with certain other calculations.

W. C. D.

1. ASTRONOMY.—In Sir R. Ball's "Elements of Astronomy," pages 388, 391 and 392, relating to astronomical constants, various calculations are given as to the masses of the earth and moon. The names of the astronomers and the dates of communication, and so on, are given, but not the "elements" by which the calculations were made; viz., parallax of the sun and the parallactic inequality of the moon. Could any of our astronomical friends furnish the information?

W. C. D.

2. METEORITES AND COMETS.—Meteorites, as well as comets, having their defined orbits, and the former, at times, trapped by our atmosphere and destroyed (or attracted to the earth), have, as far as my knowledge goes, never been described as revolving upon their own axis, besides their transitional motion, in order to bring them into harmony with other celestial movements. It would be interesting to know whether any evidence has been forthcoming to show whether this is so or not.

I fully appreciate the difficulty of solving this question, and would also like to know whether the haze round a comet's nucleus has ever been noticed to possess a more or less spiral (revolving) stratification; also, whether the spiral forms, (apparently indicating movement in a certain direction) in various nebulae, have ever been found to have varied in the length of spiral or other signs of such movement.

I would like also to know whether the shape alone of a meteorite in its orbital transit through medium, however tenuous, might not set up and retain a specific revolution.

O. C. J. O.

3. VELOCITY OF LIGHT.—I find the following sentence on page 160 in Sir J. J. Thomson's American Lectures on "Electricity and Matter":—

"It ought to be mentioned that on this view any changes in gravitation would be propagated with the velocity of light; whereas astronomers believe they have established that it travels with a very much greater velocity."

Would some reader of the "KNOWLEDGE" kindly indicate the nature of the evidence upon which astronomers base their belief that gravitation is propagated with a greater velocity than that of light.

M. BLOMQVIST.

REPLIES.

49. POLAR PHENOMENA.—The questions asked by R.K.P. in the September issue demand some space for solution. I shall endeavour, however, to give as brief an investigation as possible.

The following symbols will be used:—

ϕ to denote the latitude of the place.
δ ,, ,, Sun's declination.
h ,, ,, ,, hour angle.
Z ,, ,, ,, Zenith distance.

Referring to Figure 36, and considering the spherical triangle Z P S we have,

$$\cos Z\,S = \cos Z\,P \cos P\,S + \sin Z\,P \sin P\,S \cos h,$$
$$\text{or } \cos Z = \sin\phi \sin\delta + \cos\phi \cos\delta \cos h. \quad (1)$$

Now, as the horizontal refraction is 34′ and as the Sun's semi-diameter is 16′, the Sun's upper edge appears on the horizon when his centre is really 16′ + 34′ = 50′ below it. Making $Z = 90^\circ\,50'$, we have,

$$\cos 90^\circ\,50' = \sin\phi \sin\delta + \cos\phi \cos\delta \cos h,$$
$$\text{or } \cos h = -\tan\phi \tan\delta + \cos 90^\circ\,50' \sec\phi \sec\delta. \quad (2)$$

If h = 0, or cos h = 1, the Sun will not rise.
If h = 180° or cos h = −1, the Sun will not set.

(This is evident, since $\frac{2\,h}{15}$ is the number of hours the Sun is above the horizon; when h = 0, this is zero; when h = 180°, it is 24 hours.)

Let h = 0, then from (2)

$$1 = -\tan\phi \tan\delta + \cos 90^\circ\,50' \sec\phi \sec\delta,$$
$$\text{or } \cos\phi \cos\delta + \sin\phi \sin\delta = \cos 90^\circ\,50',$$
$$\therefore \cos(\phi - \delta) = \cos(90^\circ\,50'),$$
$$\therefore \phi - \delta = 90^\circ\,50'.$$

If $\phi = 86\frac{1}{2}^\circ$, then $\delta = -4^\circ\,20'$.

Therefore the Sun will not rise if his Southern declination is greater than 4° 20′.

If h = 180° or cos h = −1, we find in the same way that $\cos(\phi + \delta) = -\cos 90^\circ\,50' = \cos(180^\circ - 90^\circ\,50')$,

$$\text{or } \phi + \delta = 89^\circ\,10',$$
$$\therefore \delta = 89^\circ\,10' - 86^\circ\,30' = 2^\circ\,40'.$$

The Sun will not set, therefore, if his Northern declination exceeds 2° 40′.

In finding the time of continuous long dawn we shall assume that twilight begins when the Sun approaches within 18° of the horizon. The dawn will cease when his upper edge appears on the horizon, as daylight commences then.

Referring again to our first equation, we see that $Z\,S = 90^\circ + 18^\circ = 108^\circ$ when dawn commences.

Also if h = 180° or cos h = −1, twilight will continue all night, since $\frac{2\,h}{15} = 24$ hours.

Making these substitutions we find,

$$\cos 108^\circ = \sin\phi \sin\delta - \cos\phi \cos\delta = -\cos(\phi + \delta),$$
$$\therefore \cos 108^\circ = -\cos(\phi + \delta) = \cos(180 - \phi - \delta),$$
$$\therefore 108^\circ = 180^\circ - \phi - \delta,$$
$$\text{or } \delta = 72 - \phi.$$

Therefore, if $\delta =$ or $> 72 - \phi$, twilight will continue all the night, even at the time of greatest depression, *i.e.*, 18° below the horizon: hence, $\delta > 72^\circ - 86\frac{1}{2}^\circ > 14\frac{1}{2}^\circ$ S. We have seen that the Sun will just commence to rise when his Southern declination is less than 4° 20′. The twilight, or continuous dawn will, then, endure while the Sun changes from $14\frac{1}{2}^\circ$ S to 4° 20′ S.

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The following is a summary of our results:—

From 14° 30′ S to 4° 20′ S, continuous dawn.
From 4° 20′ S to 2° 40′ N, alternations of twilight and sunlight.

From 2° 40′ N until the Sun completes his most Northern course and returns again to 2° 40′ N, there will be no sunset, but one long day.

We shall now refer to the Nautical Almanac for this year. On February 10th, about 9 p.m., the Sun attains a declination

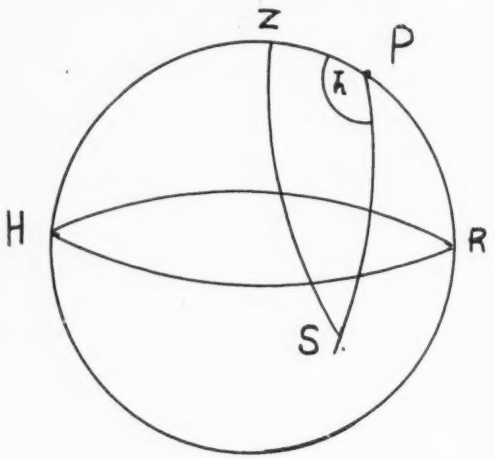

FIGURE 36.

14° 30′ S. The continuous dawn has then commenced. On March 11th, at noon, his declination is 4° 2′ 24″ S., so that twilight has commenced some time previous to this. The interval is about 28½ days. If, however, we take 17° as the angle below the horizon when twilight starts, we should reckon from 13° 30′ S. This would reduce the time of continuous dawn to 25½ days. It is easily seen from this how impossible it is to give the time of continuous dawn exactly, because the angle below the horizon varies with circumstances, such as atmospheric conditions, and so on. It is not exactly 18° under all circumstances.

On March 28th, at noon, the Sun is just short of 2° 40′ N. by 30″·7. Practically, then, we may say that the long day has commenced on March 28th. Reckoning from March 11th to March 28th, we obtain about 17 days as the time of alternation of sunshine and dawn.

On September 17th, about 8 a.m., the Sun has again attained a declination of 2° 40′ N. The time from March 28th to September 17th is 173 days. But we must deduct slightly from this, because we have assumed daylight to start the instant the upper edge of the Sun appears above the horizon. We must allow a little time after this before the long day actually commences.

For the reasons just given, we can only obtain an approximation to the number of days in each period. The figures may vary slightly according to local conditions. If we adhere strictly to the above reasoning, a latitude 86° 8′ N. gives 171 days for the long day. Probably 86½° N. most nearly fulfills all the conditions, because a less latitude than 86½° N. increases the time of alternation of sunshine and twilight.

It may be interesting to notice that in Lieutenant Shackleton's book, "The Heart of the Antarctic," it is mentioned how the Sun was seen for the last time in 1908, on April 27th, when one-third of the disc was above the horizon at noon. He was seen again first on August 17th, when his entire disc was above the horizon, and the lower edge one-fourth his diameter from it. He could, it is stated, have been seen a day or two earlier if the day had been clearer. The latitude was 77° 30′ S. This fact shows how difficult it is to predict the above times accurately to a day, as fogs and mists will always modify the results.

The Sun cannot appear in the manner suggested. Considering that his declination is increasing by about 23′ 30″ at that time, and that his apparent diameter is 32′, he could not take more than two days to rise above the horizon. If, in equation (1), we substitute 4° 2′ 24″ for δ, the declination on March 11th, and 90° 50′ for Z, and solve for h, we find $h = 23° 42'$, $\therefore \frac{h}{15} = 1 \cdot 58$ hours. The total length of the day is greater than twice this, since the increasing declination makes the afternoons longer than the mornings. His upper edge is above the horizon for a longer time than 3 hours 9 minutes on this day.

For the next day we find the time to be 4 hours 50 minutes, and for the next 6 hours 8 minutes. The whole number may be easily worked out from the formula. In these examples we assume δ to be that of noon, and neglect its small change in the time. Of course these times vary from year to year, as the Sun will not attain to precisely the same declination on the same day each year. The first day would be 1½ hours long, if the Sun's declination were somewhat less than 4° 2′ 24″.

If we reckon the time from which the Sun actually attains 4° 20′ S., that is, on March 10th at 6 p.m., to the time when he enters the Vernal Equinox, that is, 6 p.m. on March 21st, the interval is 11 days. From a few calculations we find the change of longitude in the time to be 10° 55′. If this time on March 10th correspond with the instant the Sun is in the constellation mentioned, 129°, then at Vernal Equinox we shall have 129°+10° 55′=139° 55′, differing by 3′ from the longitude given. This difference corresponds with a time of about 1 hour 12 minutes, so that the calculation by "Baroda" is practically correct for this period.

If some light were thrown on the precise time these phenomena occurred, it would simplify the calculations asked for with reference to New Moon, and so on.

(REV.) M. DAVIDSON.

51. GEOLOGY OF SOUTH DORSET (ISLE OF PURBECK).—The geology of this district offers wide scope for practical field geology on account of the number of strata which are so well exposed in coast sections. A detailed account as suggested by S.P.R. would necessitate quite a lengthy article to deal at all adequately with the geology from the point of view of strata alone, without mentioning fossils and minerals.

The chief places of interest in the locality are as follows:—

(1) Durlston Bay, where a splendid section of the Purbeck beds is exposed, and in fact duplicated in part by a fault.

(2) Swanage Bay, with Upper Purbeck at Peveril Point. Wealden, Lower Greensand, Upper Greensand and Chalk at the more northerly end of the bay.

(3) Studland Bay, with Upper Chalk and Bagshot sands.

(4) St. Alban's Head and Chapman's Pool, with Portlandian, Purbeck and Kimmeridge Clay.

(5) Kimmeridge Bay, where many faults almost diagrammatic in their distinctness may be seen.

(6) Lulworth Cove and Stairhole, showing steps in Cove formation and strata compressed and contorted.

(7) Durdle Cove, showing further stages of coast erosion and cove formation.

(8) Bournemouth, with Bagshot and Bracklesham Beds containing noted leaf beds.

I would suggest that S.P.R. should purchase "The Guide to the Geological Model of the Isle of Purbeck," by Aubrey Strahan, M.A., F.R.S.; Price 6d. Publishers: E. Stanford, 12, 13 and 14, Long Acre, London, which gives an interesting and useful account of the district required.

HERBERT E. TAYLOR.

THE FACE OF THE SKY FOR FEBRUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun.		Moon.		Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Neptune.	
	R.A.	Dec.	R.A.	Dec	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.
Greenwich Noon. 1912.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Feb. 4 ..	21 7·2	S.16·5	10 34·3	N.13·1	19 53·3	S.22·1	18 29·0	S.22·1	3 55·7	N.22·7	16 37·0	S.21·3	2 47·6	N.13·8	7 33·9	N.21·1
,, 9 ..	21 27·3	S.15·0	14 41·2	S.17·4	20 25·6	S.20·9	18 55·1	S.21·9	4 3·5	N.23·0	16 40·1	S.21·4	2 48·4	N.13·9	7 33·4	N.21·1
,, 14 ..	21 47·0	S.13·4	19 0·4	S.27·7	20 58·6	S.19·2	19 21·3	S.21·5	4 11·8	N.23·4	16 43·0	S.21·5	2 49·3	N.14·0	7 32·9	N.21·2
,, 19 ..	22 6·5	S.11·7	23 5·0	S. 9·4	21 32·2	S.16·8	19 47·2	S.20·8	4 20·7	N.23·7	16 45·7	S.21·6	2 50·4	N.14·1	7 32·4	N.21·2
,, 24 ..	22 25·6	S. 9·9	2 59·5	N.19·3	22 6·1	S.13·9	20 13·0	S.19·8	4 30·1	N.24·0	16 48·1	S.21·6	2 51·7	N.14·2	7 32·0	N.21·2
,, 29 ..	22 44·5	S. 8·0	8 9·0	N.25·4	22 40·5	S.10·4	20 38·4	S.18·6	4 39·9	N.24·3	16 50·3	S.21·7	2 53·1	N.14·3	7 31·6	N.21·2

TABLE 1.

Date.	Sun.			Moon.	Mars.						Jupiter.						Saturn.	
	P	B	L	P	P	B	L	Q	q	T	P	B	L_I	L_{II}	T_I	T_{II}	P	B
	°	°	°	°	°	°	°	°	″	h m	°	°	°	°	h m	h m	°	°
Feb. 4	−13·2	−6·3	69·2	+20·6	324·4	−12·0	91·9	78·8	·92	5 42 *m*	7·9	−2·9	351·1	151·6	2 23 *m*	7 48 *m*	−0·6	−20·7
,, 9	15·1	6·6	3·4	+16·1	324·8	11·2	44·6	79·3	·90	8 57 *m*	7·6	2·9	60·3	182·6	8 11 *e*	4 53 *e*	0·6	20·8
,, 14	16·9	6·8	297·6	−6·2	325·3	10·4	357·1	79·9	·87	0 12 *e*	7·3	2·9	129·5	213·7	8 27 *m*	4 1 *e*	0·6	20·9
,, 19	18·6	7·0	231·7	−21·5	325·8	9·5	309·6	80·6	·84	3 27 *e*	7·1	2·9	198·7	244·8	4 24 *e*	5 14 *m*	0·7	21·0
,, 24	20·1	7·1	165·9	−14·8	326·5	8·6	262·0	81·4	·82	6 43 *e*	6·8	2·9	268·1	276·0	4 39 *m*	2 18 *e*	0·7	21·1
,, 29	−21·5	−7·2	100·0	+12·1	327·2	−7·6	214·2	82·2	·79	9 59 *e*	6·6	−2·9	337·5	307·3	10 27 *e*	3 31 *m*	−0·7	−21·2

TABLE 2.

P denotes the position angle of the axis of the body measured eastward, from the North Point of the disc. B is the Heliographical (Planetographical) latitude of the centre of the disc. L denotes the longitude of the centre of the disc, T the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter there are two systems of longitude, I, for the equator, II, for the temperate zones. To find intermediate values of T apply multiples of $24^h\ 39^m$, $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{2}{3}^m$ for Mars, Jupiter I and II, respectively. Throughout these notes the time used is Greenwich Civil Time, day commencing at midnight, and the letters *m*, *e*, stand for morning and evening. Q, q, for Mars are the position angle and amount of the greatest defect of illumination.

THE SUN moves North fairly rapidly during February. His semi-diameter diminishes from 16′ 15″ to 16′ 10″. Sunrise and sunset at Greenwich, Feb. 1, $7^h\ 43^m$ *m*, $4^h\ 45^m$ *e*; Feb. 29, $6^h\ 50^m$ *m*, $5^h\ 36^m$ *e*.

THE MOON is Full, Feb. $2^d\ 11^h\ 58^m$ *e*; Last Q., Feb. $10^d\ 0^h\ 51^m$ *m*; New, Feb. $18^d\ 5^h\ 44^m$ *m*; First Q., Feb. $25^d\ 7^h\ 27^m$ *e*; Nearest Earth, Feb. $2^d\ 2^h$ *m*, semi-diameter 16′ 42″·8; Furthest away, Feb. $14^d\ 11^h$ *m*, semi-diameter 14′ 44″·3; Nearest March. $1^d\ 9^h$ *m*. semi-diameter, 16′ 30″·4. Greatest Libration 7° S. Feb. 1; 7° W. Feb. 7; 7° N. Feb. 15; 6° E. Feb. 23; 7° S. Feb. 28. The letters N. E. S. W. indicate the region of the Moon's limb (referred to our sky) carried into view by libration. Observers should watch their librational opportunities to increase our knowledge of the regions near the limbs.

Date.	Star's Name.	Magnitudes.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. to E.	Mean Time.	Angle from N. to E.
1912.			h m		h m	
Feb. 1 ...	47 Geminorum...	5·6	4.15 *m*	50°	4.45 *m*	335°
,, 1 ...	BD + 26° 1481	7·0	4.23 *m*	150	—	—
,, 1 ...	ω^1 Cancri	6·1	8. 9 *e*	68	9. 6 *e*	312
,, 1 ...	ω^2 Cancri	6·2	8 35 *e*	125	9.37 *e*	256
,, 2 ...	BD + 24° 1903	7·0	4.41 *m*	40	—	—
,, 2 ...	λ Cancri	5·9	5.10 *m*	54	5.39 *m*	345
,, 3 ...	BAC 3443	6·3	8.16 *e*	123	9.16 *e*	280
,, 4 ...	BAC 3759	7·0	—	—	8.13 *e*	337
,, 6 ...	BAC 4083	7·1	—	—	6.15 *m*	183
,, 8 ...	86 Virginis	5·6	6.24 *m*	154	7.25 *m*	268
,, 11 ...	BAC 5403	6·0	5.38 *m*	103	7. 1 *m*	299
,, 13 ...	BAC 6072	5·8	—	—	5.25 *m*	288
,, 24 ...	τ^2 Arietis	5·2	8.31 *e*	85	9.34 *e*	242
,, 24 ...	65 Arietis	6·0	9.23 *e*	98	10.19 *e*	232
,, 27 ...	BAC 1754	5·7	2.36 *m*	131	3.13 *m*	231
,, 28 ...	BD + 27° 1164	6·9	0.41 *m*	165	—	—
,, 28 ...	BD + 27° 1194	7·7	2.39 *m*	164	—	
,, 29 ...	c Geminorum	5·5	1.14 *m*	114	2.10 *m*	281

TABLE 3. Occultations of stars by the Moon visible at Greenwich.

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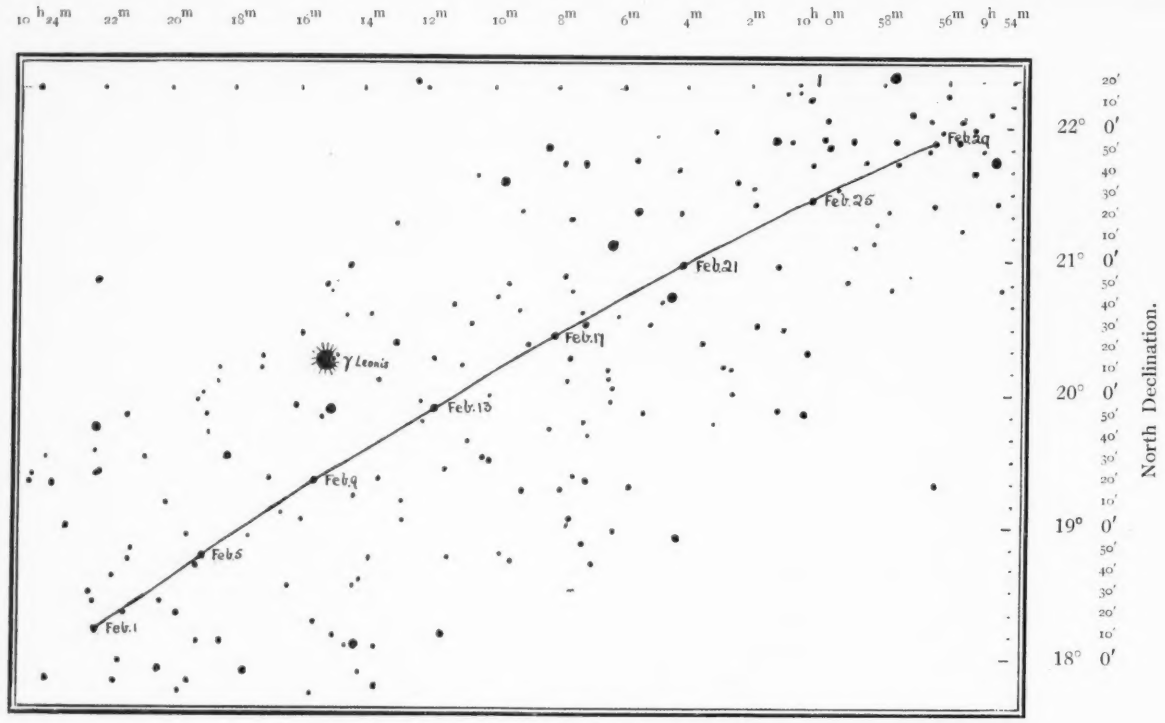

FIGURE 37. The Path of Vesta in February, 1912.
The Stars range in magnitude from 2 to 9½.

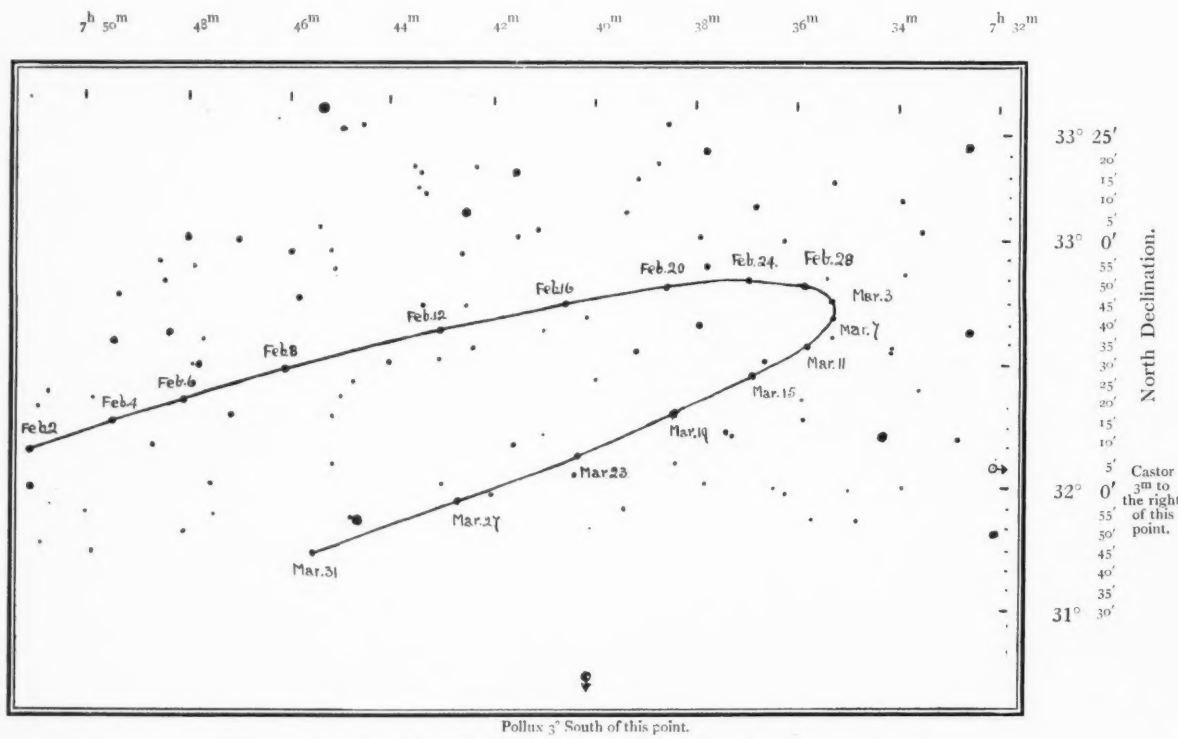

FIGURE 38. The Path of Ceres in February and March, 1912.
The Stars shown range in magnitude from 6½ to 9½.
On February 2nd Ceres has the same Declination as Castor, following it by 22 minutes. To find the planet point a telescope at Castor and leave it stationary for 22 minutes.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle.	Distance.	Colours.
	h. m.					
Struve 1024	7 4	38° 18′N	8·3, 8·8	316°	1″	Yellow, white.
,, 1037	7 7	27 23 N	7·1, 7·1	295	½	White.
,, 1051	7 16	73 15 N	6·5, 8·6	282	1	Triple, white.
			6·5, 6·7	82	31	
,, 1055	7 15	60 5 N	6·0,10·5	324	2	White.
λGeminorum	7 13	16 42 N	3·2,10·3	33	9	Bluish-green.
19 Lyncis	7 16	55 27 N	5·3, 6·6	315	15	Bluish-white.
20 Lyncis	7 16	50 19 N	6·6, 6·8	254	15	White.
δGeminorum	7 15	22 9 N	3·2, 8·2	209	7	Yellow, blue.
Struve 1083	7 20	20 40 N	6·8, 7·8	43	6	Yellow, blue.
,, 1097	7 24	11 23 S	6·3, 8·2	169	1	Quadruple.
			6·3, 8·7	313	20	
			6·3,10·6	157	23	
,, 1104	7 25	14 49 S	6·7, 8·3	332	2	White.
Castor	7 29	32 5 N	2·7, 3·7	222	5½	Yellowish-green.
Struve 1116	7 29	12 29 N	7·0, 7·7	106	2	White.
,, 1121	7 33	14 18 S	7·2, 7·5	304	7	White.
,, 1122	7 38	65 22 N	6·8, 7·6	5	15	White.
,, 1126	7 35	5 26 N	7·2, 7·5	145	1	White.
			11′ East of Procyon.			
,, 1127	7 39	64 17 N	6·2, 8·5	338°	5″	Triple.
			6·2, 9·0	175	11	
,, 1138	7 40	14 28 S	6·2, 7·0	339	17	White.
,, 1146	7 44	11 59 S	5·3, 7·4	13	3	Yellow, blue.
,, 1177	8 0	27 49 N	6·5, 7·4	352	3	Bluish-white.
,, 1178	8 4	32 29 N	7·1, 8·0	46	2	Yellow.
ξCancri	8 7	17 55 N	5·0, 5·7	2	1	Triple.
			5·0, 5·5	114	5	
Struve 1216	8 17	1 19 S	7·5, 8·2	215	½	White.
ϕ^2Cancri	8 21	27 14 N	6·0, 6·5	217	5	Yellowish.
υ^1Cancri	8 21	24 50 N	6·0, 7·1	41	6	White.
Struve 1245	8 31	6 56 N	6·0, 7·0	25	10	White.
,, 1263	8 39	42 1 N	7·6, 8·2	22	60	White.
		An optical double. 7·6 has large proper motion.				
ιCancri	8 41	29° 6′N	4·4, 6·5	307°	30″	Yellow, blue.
εHydrae	8 42	6 45 N	3·8, 7·8	222	¼	Quadruple.
			3·8, 8·5	231	4	
			3·8,12·0	195	20	
σ^2Cancri	8 49	30 56 N	5·9, 6·4	326	1½	Yellow.
66Cancri	8 56	32 36 N	6·1, 8·2	138	4	White, blue.

FIGURE 4. Double Stars between Right Ascension 7^h and 9^h.

MERCURY is badly placed for Northern observers, but may be seen as a morning star at the beginning of the month. It presents a nearly full disc, being in superior conjunction on March 1st. It is on the same parallel as Venus on February 4th, and may be found by pointing a telescope at Venus, and leaving it stationary for $1^h\ 24^m$.

VENUS is also rather badly placed, being South of the Sun; $\frac{4}{5}$ of the disc is illuminated, the diameter diminishing from 14½″ to 12½″.

MARS is still a bright evening star in Taurus, but is rapidly receding from us. The diameter diminishes from 10″ to 7″. The seasons on the planet correspond to the first half of April on Earth. Both poles are invisible, since the Sun and Earth are on opposite sides of the planet's equator.

CERES and VESTA are both well placed, the latter being in opposition on February 16th. Its magnitude is 6½, so that it might be glimpsed by a keen eye without optical aid. The positions of the two planets are sufficiently shown by maps indicating the configuration of surrounding stars. Vesta is 50′ South of γ Leonis, on February 9th.

JUPITER is better placed than last month, but its South declination is a drawback to Northern observers. The equatorial diameter increases from 34″ to 36½″. The polar is 2¼″ less. Defect of illumination nearly ⅓″. The diagram shows the configurations of the four large Satellites at 5^h *m*.

Day.	West.	East.	Day.	West.	East.
Feb. 1	3 ⊙ 24		Dec. 16	32 ○ 4 I●	
,, 2	32 ○ ¼		,, 17	31 ○ 4 2●	
,, 3	4¾ ○ 2		,, 18	○ ¾24	
,, 4	4 ○ 1½		,, 19	12 ○ 43	
,, 5	4½ ○ 3		,, 20	¾ ○ 13	
,, 6	42 ○ 13		,, 21	41 ○ 32	
,, 7	413 ○ 2		,, 22	43 ○ 12	
,, 8	43 ○ 12		,, 23	432 ○ I●	
,, 9	¼2 ○ 1		,, 24	432 ⊙	
,, 10	¾1 ○ 2●		,, 25	4 ○ ¾2	
,, 11	○ 4132		,, 26	41 ⊙ 3	
,, 12	12 ○ 43		,, 27	24 ○ 13	
,, 13	2 ○ 134		,, 28	1 ○ 2¾	
,, 14	1 ○ 324		,, 29	3 ○ 124	
,, 15	3 ○ 124				

TABLE 5.

Phenomena visible at Greenwich:—I. Sh. E. $1^d\ 4^h\ 12^m$, II. Sh. I. $5^h\ 16^m$, I. Tr. E. $5^h\ 18^m$; II. Oc. R. $3^d\ 4^h\ 30^m$, III. Ec. D. $7^h\ 30^m\ 22^s$; III. Tr. E. $7^d\ 3^h\ 43^m$, I. Ec. D. $6^h\ 43^m\ 52^s$; I. Sh. I. $8^d\ 3^h\ 52^m$, I. Tr. I. $5^h\ 1^m$, I. Sh. E. $6^h\ 5^m$, I. Tr. E. $7^h\ 14^m$; I. Oc. R. $9^d\ 4^h\ 32^m$; II. Oc. R. $10^d\ 7^h\ 10^m$; III. Tr. I. $14^d\ 5^h\ 56^m$; I. Sh. I. $15^d\ 5^h\ 45^m$, I. Tr. I. $6^h\ 57^m$; I. Ec. D. $16^d\ 3^h\ 5^m\ 51^s$, I. Oc. R. $6^h\ 29^m$; I. Tr. E. $17^d\ 3^h\ 39^m$, II. Ec. D. $4^h\ 49^m\ 54^s$; II. Tr. E. $19^d\ 4^h\ 52^m$; III. Sh. I. $21^d\ 5^h\ 5^m$, III. Sh. E. $6^h\ 59^m$;

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I. Ec. D. $23^d\ 4^h\ 59^m\ 19^s$; I. Tr. I. $24^d\ 3^h\ 21^m$, I Sh. E. $4^h\ 19^m$, I. Tr. E. $5^h\ 34^m$; I. Oc. R. $25^d\ 2^h\ 53^m$; II. Tr. I. $26^d\ 4^h\ 52^m$, II. Sh. E. $4^h\ 59^m$. The above are all in the morning hours; phenomena separated by commas are all on the same day. Eclipses occur high left of the disc in the inverted image, taking the direction of the belts as horizontal. IV. does not undergo eclipse at present.

SATURN is approaching the Sun, but still easily observable. Equatorial diameter 18″. Major axis of ring 41″, minor 15″. The following Table gives East elongations of Satellites. To find intermediate ones apply multiples of $1^d\ 21^h$ for Tethys, $2^d\ 18^h$ for Dione, $4^d\ 12\frac{1}{2}^h$ for Rhea.

Tethys Feb. $1^d\ 11^h\ e$; $7^d\ 3^h\ e$; $13^d\ 7^h\ m$; $18^d\ 11^h\ e$; $24^d\ 3^h\ e$; $28^d\ 9^h\ m$. Dione Feb. $1^d\ 5^h\ e$; $7^d\ 5^h\ m$; $12^d\ 4^h\ e$; $18^d\ 4^h\ m$; $23^d\ 3^h\ e$; $29^d\ 3^h\ m$. Rhea Feb. 1^d *noon*; $10^d\ 1^h\ e$; $19^d\ 2^h\ e$; $28^d\ 3^h\ e$. For Titan and Iapetus E., W., denote East and West Elongations, I.S. Inferior and Superior Conjunctions. Titan Feb. $2^d\ 8^h\ m$ I, $6^d\ 4^h\ m$ W, $10^d\ 2^h\ m$ S. $14^d\ 6^h\ m$ E, $18^d\ 7^h\ m$ I, $22^d\ 4^h\ m$ W, $26^d\ 2^h\ m$ S; March $1^d\ 6^h\ m$ E. Iapetus Feb. $5^d\ 8^h\ m$ W, $24^d\ 5^h\ e$ S.

URANUS remains invisible.

NEPTUNE is very well placed in Gemini. The map given last month is still available for finding it.

COMETS.—Ephemerides for three comets in February were given last month. Prolonged observation of Quenisset's comet is desirable, as it may possibly be identical with 1790, III.

METEORS.—Mr. W. F. Denning gives the following showers.

Date.	Radiant. R.A.	Radiant. Dec.	Notes.
Feb. 5-10 ..	75°	41° N	Slow, bright.
,, 15 ...	236	11 N	Swift, streaks.
,, 15 ...	261	4 N	Swift, streaks.
,, 20 ...	181	34 N	Swift, bright.
,, 20 ...	263	36 N	Swift, streaks.

MINIMA OF ALGOL.—Feb. $1^d\ 3^h\ e$, $10^d\ 5^h\ m$, $18^d\ 7^h\ e$, $27^d\ 10^h\ m$. Period $2^d\ 20^h\ 49^m$. Every 3rd minimum given.

CLUSTERS AND NEBULAE.

Name.		R.A.	Dec.	Notes.
♃ IV.	45	$7^h\ 23^m$	21° 7′ N.	Nebula.
♃ VI	1	7 32	21 48 N.	Cluster.
♃ VIII.	38	7 32	14 13 S.	Loose cluster.
♃ VI.	37	7 35	10 28 S.	Cluster.
M.	46	7 37	14 34 S.	Cluster.
♃ VI.	64	7 38	17 56 S.	Planetary nebula.
M.	93	7 40	23 35 S.	Cluster.
♃ VII.	11	8 6	12 36 S.	Loose cluster.
♃ VI.	22	8 9	5 28 S.	Cluster.
M.	44	8 34	20 20 N.	Praesepe cluster.
M.	67	8 46	12 13 N.	Cluster.

MATHEMATICS AND PHYSICS IN THE ENCYCLOPAEDIA BRITANNICA.

THE eleventh edition of the "Encyclopaedia Britannica" is of a vintage, which, judging from the initials of the contributors of its articles on mathematical and physical subjects, needs a bush no more than the ninth edition. Bush or no bush, such a production cannot pass unnoticed, though to discuss adequately even one group of articles is beyond the powers of this reviewer, even if the attempt were not beyond the scope of this journal.

Mathematics and physics have always been special features of this work, and in the present edition the compilers have kept this fact in mind. There is not in English, as there is in French and German, a Dictionary or Encyclopaedia of Mathematics, and the eleventh edition of the "Encyclopaedia Britannica" aims definitely at supplying this need. This means that a large number of new articles have been written, while a few of the older articles re-appear. Among these, of course, we find treatises by such men as Cayley and Tait, which have become in a measure classical. On the other hand we have our attention called to the modern trend of mathematical thought by the new article "Mathematics." This, contributed by A. N. Whitehead, takes the place of Professor Chrystal's article. The same author, with Mr. Bertrand Russell, contributes sections under the heading "Geometry," an article which combines old and new. Professor O. Henrici discusses Euclidean, Prospective, and Descriptive Geometry, while Cayley's Analytical Geometry has been revised by Professor E. B. Elliott. Among other contributors in Pure Geometry we notice the names of E. W. Hobson, A. E. H. Love and H. F. Baker. In Applied Mathematics Professor H. Lamb, Sir George Greenhill, and Sir George Darwin, are noteworthy contributors. Physical Science moves so fast now-a-days that a treatise may become out of date in the course of its preparation for the press. We refer, of course, more particularly to the rapid growth of the new study of radio-activity. But the new views on the structure of matter are bound to have their effect in all branches of Physics. In the eleventh edition the group of articles of which the Properties of Matter and the Aether form the theme are particularly noteworthy. Part of Clerk Maxwell's famous article "Atom" can never be out of date, and reappear under the heading "Molecule." The present occupant of Maxwell's chair, Sir J. J. Thomson, contributes a new article "Matter." Sir Joseph Larmor's "Aether" contains all that was valuable in Maxwell's "Ether" modified in accordance with the prevalent views.

More of Maxwell's distinctive work reappears in Lord Rayleigh's "Capillary Action" and Professor G. H. Bryan's "Diffusion." Lord Kelvin, the last survivor of the great "Early Victorian" group of Cambridge Physicists, contributed two famous articles to the ninth edition: "Elasticity" and "Heat." He survived long enough to be consulted with regard to these, and there can be no question that in handing over to Professors A. E. H. Love and H. L. Callendar the task of bringing them up to date, he made an admirable choice. In the region of "Light" Lord Rayleigh is fortunately still with us, and his new articles on "Diffraction" and "Interference," both of them experimental as well as mathematical, take the place of his former "Wave Theory" and Professor Tait's "Light." The remarkable advance in optical instruments due to the work of Abbé and Schott finds recognition; and articles on "Lens" and "Aberration" have been contributed by members of Zeiss' staff at Jena.

In Electricity and Magnetism a noteworthy transformation has been made. Professor G. Chrystal, of Edinburgh, taken by death from his work since these pages came into the reviewer's hands, was the author of the articles in the ninth edition, which were regarded as the best existing text-book of the "eighties." In their place we now find a series of articles by Professor J. A. Fleming, Sir J. J. Thomson and others, which are as far as possible up-to-date, and which by their headings and arrangement simplify the process of reference. As an example of the difficulty of keeping abreast of the times in such a work as this the reviewer may mention that he has been unable to find either under the heading "Compass" or "Gyrostat" any reference to the Gyrostatic Compass.

XUM

REVIEWS.

AERONAUTICS.

Natural Stability in Acroplanes.—By W. Le Maitre. 46 pages. 33 illustrations. 7¼-in.×4¾-in.

(E. & F. N. Spon. Price 1/6.)

This book is the expression of the personal opinion of the author on the subject forming the title. There is also a rough description of a machine designed in accordance with principles which he has deduced from experiments made with small gliders.

His main deduction is that machines with short wing span and low centre of gravity will make the best and most "efficient" machines.

The author seems to be under the impression that his principles have never been tried; he is very much mistaken on this point.

As to the deductions themselves, short span and very low centre of gravity are almost diametrically opposed to the generally accepted necessary conditions for proper efficiency, and the propriety of these conditions, besides being demonstrable by laboratory experiment, is fully confirmed by the results in practice.

It is also a fairly well-known fact that by increasing or adding to the resistances of an aeroplane, one can increase its stability, but at the expense of its efficiency or the power necessary for flight.

The only proper deduction from the author's experiments is that a machine constructed to the author's designs, when once up, could, on a very calm day, form a steady glide to earth, (somewhat steep, very possibly), but that such an inefficient machine ever would "get up" is, to say the least, problematical.

T. W. K. C.

Langley Memoir of Mechanical Flight.

(Published by the Smithsonian Institution, Washington).

In this book we have the long looked for full description of all the wonderful and patient experimental work of the late Mr. Langley. The work, which has taken eight years to complete, is a monument to the single-minded thoroughness of the experimenter, and to the untiring energy of his most able assistant, Mr. Manley, and the result far exceeds the most sanguine expectations.

The size of the work precludes any adequate description of its contents; suffice it therefore to remark that it consists of over three hundred pages of text, written in a clear, concise and interesting manner, and well printed on good paper. There are in addition one hundred and one full page plates, all clearly reproduced from photographs. These shew various rubber driven models (there are thirty-one of these), power models (four of these), the same in flight, launching apparatus, man-carrying machines, surfaces, automatic equilibrium devices, boilers, and numerous others, most of them having their details shewn separately.

Here may be read the troubles attendant on making light motors, and how, (in 1900), when searching over Europe for a light petrol motor, all the builders were agreed that a light twelve horse-power motor could not be built to weigh less than two hundred and twenty to three hundred and thirty pounds, and how finally Mr. Manley personally assumed the responsibility of making the same, and successfully produced one of twenty-four horse-power weighing one hundred and twenty pounds only, a result comparable with present engines.

To those who interest themselves in "Flight" this book is essential.

T. W. K. C.

CHEMISTRY.

The Relative Volumes of the Atoms of Carbon, Hydrogen and Oxygen, when in Combination.—By Hawksworth Collins, B.A. (Cantab.). 107 pages. 8½-in.×5½-in.

(Morton & Burt. Price 7/6 net.)

To Hermann Kopp is due the honour of having made the first systematic attempt to discover the relation between the chemical constitution and the physical properties of bodies. Amongst these properties he gave perhaps greatest attention to that of molecular volume. He concluded that molecular volume is an additive property, *i.e.*, that the volume of an atom in combination is a fixed quantity (within certain limits) at any temperature, and that the volume of any molecule is the sum of the volumes of its constituent atoms. He assigned the following values to the atoms of Carbon, Hydrogen and Oxygen—C = 11; H = 5·5; O = 12·2 or 7·8 according to whether it is carbonyl-oxygen or hydroxyl-oxygen. Researches carried out since the time of Kopp have shown that the matter is not so simple as this: the arrangement of the atoms has a decided influence upon the molecular volume, (as Kopp recognised in the case of oxygen), isomeric bodies by no means always having the same molecular volumes.

The author of the present work has given many years of study to the solution of this problem, seeking for some consistent method of interpreting the values for the molecular volumes of various compounds obtained by experimental chemists. And as a result of this study, he has devised a method of calculating the molecular volumes of various bodies with a quite remarkable degree of accuracy. In the present work he deals only with compounds containing carbon, hydrogen and oxygen. He finds that the molecular volumes of such bodies at 15° C may be calculated by giving the following values to these atoms—C = ·71, or in some cases 8·0; H = 15·25, 12·22, 9·95, or 5·76; O = 2·51, 4·45 or 7·53; the different values of the elements being assigned according to certain fixed rules.

The fact that it is necessary to give different values to the atoms of hydrogen and oxygen, he explains by the theory that the four valencies of carbon are not equal, and that the volumes of other atoms differ according to which carbon valence they are combined with. There are immense difficulties in the way of accepting this theory, however, and the fact discovered by Mr. Collins, that in order to calculate accurately the molecular volumes of carbon compounds we must assign differing values to the hydrogen and oxygen atoms may be explained otherwise, and we think, more easily. For, in the first place, there is the probability that the volume occupied by an atom is affected by neighbouring atoms; and, in the second place, we have shown elsewhere ("On the Calculation of Thermo-Chemical Constants") that the true atomic values for any physico-chemical property are unobtainable in the present state of knowledge, the supposed atomic values obtained being really the differences between the values of such atoms and their linkages and the influences due to the linkages broken by the introduction of these atoms into the molecule. Regarding Mr. Collins' values of the atomic volumes as the values of such differences, his work is of considerable worth. So little is really known of what may be termed the physics of molecules, that every addition to this subject is especially welcome. Physical chemists will doubtless give Mr. Collins' interesting book the careful attention it deserves.

H. S. Redgrove.

XUM

EVOLUTION.

The Mutation Theory.—Vol. II.—The Origin of Varieties by Mutation. By HUGO DE VRIES, Professor of Botany at Amsterdam. 683 pages. With 149 figures and six coloured plates. 9½-in. × 6-in.

(Kegan Paul, Trench, Trübner & Co. Price 18/- net.)

The principal features of the theory of Mutation were dealt with at length by Professor de Vries, in his two volumes published in German in 1901 and 1903, in which he endeavoured to present as completely as possible the detailed evidence obtained from trustworthy historical records, and upon his own experimental researches, on which the theory is based. In 1904, Professor de Vries delivered a course of lectures on this subject in English, at the University of California, at Berkeley in that State, in which those points were emphasized most suitable for scientific demonstration to a class of advanced students.

The present volume is a translation by Professor J. B. Farmer and Mr. A. D. Darbishire, of the second volume of a later enlarged edition of the original work, embodying the most recent researches, and including the results of confirmatory and independent experiments; and omitting certain generalities and the presentation of such ancillary statements as are desirable in first formulating the basis of a new theory.

The distinguished author is insistent on his theory representing a *phase* of Evolution, neither antagonistic to the theories of Darwin and of those who followed him, nor detachedly critical of them, but complementary and to a certain extent supplementary to them. Darwin contrasted Natural Selection with Artificial Selection. Natural Selection, which formerly occupied such a prominent place in the Darwinian scheme of the survival and salvation of the fittest (a prominence, however, which was neither sanctioned nor encouraged by Darwin himself either in his correspondence or in his later works), is now, by general consent, relegated to the more subordinate position of an agency which is no longer considered causal, but directive.

As Professor de Vries implies, even before the appearance of Darwin's works, it was recognized that the task of systematic biology as a descriptive and classificatory science was different from the mere question of actual kinship. The factor of convenience for the purposes of scientific study had to be introduced as an index to investigation before the required data of morphological facts had been ascertained. At the very moment of the appearance of Darwin's "Origin of Species," the French botanist, Godron, was publishing a work "De l'Espèce et des Races dans les Êtres Organisés." It may be urged that the author's range of biological research is circumscribed in the demonstration and application of his theory. The origin of species is an object of inquiry and of investigation in all three of the biological sciences of Anthropology, Zoölogy, and Botany. Natural selection is least obvious in the last. Not only is this the section to which Professor de Vries almost exclusively confines his scope of inquiry, but he further restricts it to garden cultures rather than to wild and native plants, in which former category the working of Natural Selection is reduced to a minimum. Where sceptics would like to see the interplay or at least the segregating factors of Mutation-phenomena is in the indigenous flora or, better still, among ethnic types. It is not in accord with the cosmic process of Evolution that diverse results of similar incentives to variation should co-exist in one or more groups of biological phenomena, or in one more obviously than in the others.

The subject is boldly handled in the section on "Systematic Biology and the Theory of Mutation" (page 567). The author essays to clinch the argument by a challenge, that if it can be shown that the mutation theory satisfies the demands of systematic science on the one hand, and of embryology on the other, better than the present form of the theory of selection, its justification as a theory of the nature of inheritance will, in his opinion, be placed on a sure foundation. With the enthusiasm born of empirical theory and of experimental investigation, and with a wealth of illustration, he proceeds to demonstrate the applicability of the theory of mutation to the main conclusions of the doctrine of Evolution,—that blessed word which the late Lord Salisbury compared with "Mesopotamia" as a comforting sedative for the minds of jaded theorists.

Here, however, there is some special pleading, and much is made of the experience of gardeners and of interfering hybridists. But, however much Inorganic Nature may abhor a vacuum, it can hardly be said that Organic Nature abhors hybridity. It, in fact, rather resents the opposite extreme,—cleistogamy; and does its best to thwart it. Further than this, the hybrid-products familiar as the Common Lime and the Common Elm are more vigorous than their original pairs of parents. On the other hand, the normal fertility of *Salix*-hybrids, and those of *Mentha* and *Rubus*, and of garden-hybrids in Primulaceae, is a well-established fact.

In his concluding pages, the author comments on the geological periods of mutation. Quoting from Lord Kelvin, W. K. Brooks and Professor K. E. Schneider, he agrees with those who assume that in cosmic history there have been special periods of great variability; for instance, "when land-animals, and again when Man, originated." In these periodical waves of rapid and intensive variation unusually active within a definite time, the author, if he accepts the principle of such modes of origin, comes dangerously near an attempted revival of Cuvier's cataclysmal theory, long ago exploded and relegated to oblivion. The writer of this notice humbly ventures to dissent from the *dictum* that this is a question of comparative anatomy and of systematic science. It *was* a question among the more rampant teleologists of the pre-Darwinian days, but it was one which has been convincingly and finally answered.

However much one may dissent from the wide and comprehensive application and the enlarged scope of the theories of Mendelian heredity and of mutational variation in contrast with the original and restricted claims of those who defined them, one cannot but welcome this bold presentation of an attractive theory, which Professor De Vries supports and fortifies with the aid of a laborious, co-ordinating, and instructive series of experimental investigations, and which will strongly appeal to all serious students of Biology,—both those who endeavour to absorb and assimilate all the new light which may be shed on the problems of Evolution, and those who are perplexed with the apparently conflicting and discordant "biochronic equations" which occupy such a subordinate place in their correlation.

FREDERIC N. WILLIAMS.

GEOGRAPHY.

New Zealand.—By THE HON. SIR ROBERT STURT, K.C.M.G., LL.D., and J. LOGAN STURT, LL.B. The Cambridge Manuals of Science and Literature. 185 pages. 20 illustrations. 6½-in. × 4¾-in.

(Cambridge University Press. Price 1/- net.)

This little book forms one of the Cambridge Science and Literature Series; in our opinion its contents are neither the one nor the other, and we do not quite see for whom the book has been written. True, a great deal of information is stored in its hundred and eighty-five pages, and the names of its distinguished authors are a sufficient guarantee of accuracy, but further than this we cannot commend the book. We should certainly hesitate to place it in the hands of a schoolboy. As a book of reference, or as a guide to New Zealand, it does not seem to be sufficiently detailed, while as an introduction to the study of the country, its produce and people, it fails to stimulate curiosity or interest.

Modern geography teaching consists not merely of the stringing together of facts, to be committed to memory by the pupil, but it tries to answer the question "Why," and after presenting certain principles, shows as far as possible how these may be brought to explain not only the physical but the political geography of a country as well. We look in vain for any such guiding plan in the volume under review. We hold that a crowd of facts with little or no explanation is useless

from an educational point of view, and that the facts themselves, even if retained in the memory, are not likely to be of much value to the general reader. The book, however, would probably be of service for the answering of examination questions of a certain type.

The illustrations taken from photographs are fairly successful, the one of Lake Ada being perhaps the best; but surely a good map would have been a more useful frontispiece than a specimen of Maori carving!

M. D. H.

Textbook of Geography.—By G. C. FRY, M.Sc. 2nd Edition. 468 pages. 96 Figures. 5-in.×7-in.

(University Tutorial Press. Price 4/6.)

In the second edition of this useful textbook a large number of maps and diagrams have been added. The statistical information is brought up-to-date, and an appendix containing numerous examination questions is supplied. These certainly add to the utility of this compact and comprehensive textbook. Whilst the illustrations are in general good and clear, some of the coloured maps are not very successful, notably Figure 76. The book is intended for matriculation students, and is extremely well written and arranged.

G. W. T

GEOLOGY.

The Changeful Earth.—By G. A. J. COLE, M.R.I.A., F.G.S. 223 pages. 51 Figures. 4½-in.×7-in.

(Macmillan & Co. Price 1/6 net.)

This fascinating little book is one of a series of "Readable Books in Natural Knowledge," which is intended to stimulate interest in scientific studies, and "to present natural phenomena and laws broadly and attractively." That the book under review fulfils this object goes almost without saying. Prof. Cole has written in his most attractive style the romantic story of geology as it is recorded in the lives and labours of its great pioneers. The history of the changeful earth is told in a series of chapters which describe the achievements of the pioneers in each branch of the science. The reader is gently led up to the present position of geology by a consideration of the development of the fundamental conceptions of the science in the minds of its earlier exponents. In the capable hands of the author this method of presentation is most successful, and we have read few books which are so likely as this to produce a lasting and fruitful enthusiasm for geology. The book is written in a simple and charming style, and makes its appeal as literature quite as much as by its interesting subject matter. As an introduction to geology for nature-students it will be found invaluable.

G. W. T.

ORNITHOLOGY.

The Home-life of the Osprey.—Photographed and described. By CLINTON G. ABBOTT, B.A. 54 pages. 32 plates. 10¼-in.×7½-in.

(Witherby & Co. Price 6/- net.)

The observations and photographs contained in this work were made in the Eastern States of America, and Mr. Abbott, knowing that the Osprey is all but extinct in Britain, and that any nests existing in recent years were in solitary and remote places in the Scottish Highlands, remarks on the surprise with which he saw his first American Osprey's nest. "It was," he writes, "at a popular seaside resort in New Jersey, and perched on a tree over a lake full of row-boats and noisy holiday-makers" (page 7). The bird probably still nests, or attempts to do so, within the bounds of the city of New York, and on Gardiner's Island about three miles from Long Island (where the species has been protected for many years), it is estimated that some two hundred nests are in existence. Mr. Abbott has put his opportunities on this island and elsewhere to excellent use, and has given us a series of valuable personal observations on the fishing, breeding and other habits of the Osprey, and on the rearing and conduct of young birds in the nest. He gives an instructive narrative of a continuous twenty-five hours watch with his camera close to a nest with young, the object being to ascertain some definite data as to how often young Ospreys are fed. During this watch food was only brought to the nest three times, and Mr. Abbott thinks that the young are not fed more than twice, or at the most, three times a day; this infrequency surprises him, and he asks for further information.

The numerous photographs by Mr. Abbott and Mr. H. H. Cleaves accompanying the work are very fine indeed, and it is not too much to say that by themselves they tell the story of the bird. Some particulars are given of the photographic methods adopted in securing these pictures and the enthusiastic pleasure which Mr. Abbott expresses in this work is well justified.

H. B. W.

Report on the Immigrations of Summer Residents in the Spring of 1910. Also Notes on the Migratory Movements during the Autumn of 1909.—By the COMMITTEE APPOINTED BY THE BRITISH ORNITHOLOGISTS' CLUB. 314 pages. 21 maps. 8¾-in.×5¾-in.

(Witherby & Co. Price 6/- net.)

This is the sixth annual consecutive Report of the valuable and important work being done by the Migration Committee of the B.O.C., and they explain that the lines followed are similar to those of previous Reports. A great amount of information is given, but no remarkable phenomena or abnormal movements seem to have occurred during the period reported on, and the records are almost entirely similar to those of previous Reports and, of their kind, well known to observers and students. The accumulation of facts on a uniform system over a series of years is of essential importance in such researches, but it may reach a point at which it ceases to be information. For instance, it seems superfluous, and in no way an addition to our knowledge, to give in detail the ordinary dates of the arrivals of common summer bird-visitants, and these might be taken for granted, and only departures from the normal chronicled. Both the Editor and the Committee remark on the voluminous character of the Report and their endeavours to condense it. The attainment of this end would be assisted by their publishing only observations and returns of material importance throwing fresh light on the subject or containing new records. The space thus made available might be utilized in extending the field of the enquiry and amplifying its usefulness. A real advance might be attempted in co-opting and co-ordinating observations made by others, a task which the influence and learning of the B.O.C. make more likely of attainment by them than otherwise. The limited character of the Report as now compiled is shown in one direction by the records given of a few of the scheduled birds from the Clyde district (thus extending the work beyond England and Wales), while records of other birds in that district are ignored, as well as the whole of the information published elsewhere for other parts of Scotland.

The immigrants reported on in detail in the volume are thirty-three in number, and twenty-one of them are also separately mapped, a graphic and useful assistance. The "unscheduled birds" (pages 160-181) and those dealt with in the "Notes on the Migratory Movements during the autumn of 1909" (pages 200-260) are somewhat hidden, by not being named in the table of contents (there is no index), but there are some excellent short accounts of bird-movements under these headings. The reports on the Starling (pages 167 and 233) and the Crossbill (page 231) may be specially mentioned. Under the last-named the apposite remark is made that "if the true cause of these sporadic irruptions of certain species were known we might have a clue to the beginnings of the migratory instinct." Might this conjecture not be extended to include the sporadic movements of any species?

H. B. W.

TIDES.

The Tides and Kindred Phenomena of the Solar System.—By SIR G. H. DARWIN, K.C.B., F.R.S. Third edition, 1911. 437 pages. 46 illustrations. 8-in.×5-in.

(John Murray. Price 7/6 net.)

Successive editions of a book afford some test of the general need or approval for the work; it proves that the

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author has succeeded in producing a work that interests others besides himself.

The book under consideration is written in non-mathematical language. The feature of it is the singularly small amount of technical formulae that a skilled author needs in describing pleasantly and interestingly such a highly scientific and complex subject as the Tides. It requires a master-mind to render the subject easily intelligible to common folk and at the same time to preserve its standard so high that no scientific library can be efficient without possessing a copy as a text-book or book of reference. The book has now become indispensable to the astronomer and the observatories, to the geodesist and geographer; in short, to all who wish to know up-to-date facts of the cosmos, particularly of those important specks in the universe—the earth and moon.

There was good reason for a new edition of this work, and it is expressed in the author's own words, "Even in so short a period of time as five years [the author had written the manuscript for the first edition in 1897, though not published until October, 1898] the aspect of some parts of my subject had already changed considerably, so that in 1902 some alterations had become necessary, and now, after a further lapse of eight years, yet more extensive revision is needed. It is scarcely possible to revise an old book so as to make it into a new one, and it is not, perhaps, desirable to attempt to do so, because there is a certain interest in observing the gradual development of scientific thought. It seemed to me, therefore, that the best way of incorporating into this volume the recent advances of science was to add supplements to the several chapters, and only to make minor alterations in the original text."

The chapters—the tidal theory pervading them—which are of more general astronomical interest, or those beyond the regions of our earth and its satellite, are those on Saturn's Rings (Chapter XVIII, originally Chapter XX in the first edition), Figures of Equilibrium of a rotating mass of Liquid (Chapter XIX), Speculations as to the Origin of Double-Stars (Chapter XX), and the Evolution of Celestial Systems (Chapter XXI), the last three chapters being new or re-written.

We notice an error in the chapter on Saturn's Rings at the foot of page 336. The discovery of the inner dark, or crêpe, ring is credited to Bond and Dawes, as having been made in 1850; though these two eminent observers undoubtedly saw that ring independently for the first time, the credit of placing the discovery definitely on record should have been given to Dr. J. G. Galle, who had made a series of observations of this dark ring in 1838. These were published a few months later.

Not the least valuable portions are the numerous references to the works of those upon which the book is based, and the index—the part of a book often scamped. A few other later references might have been added with advantage to some of the chapters.

The first edition had three hundred and thirty-four pages of text in twenty chapters, and eight pages for the index, with forty-three illustrations; the third edition is expanded to four hundred and twenty-six pages in twenty-one chapters, and ten-and-a-half pages of index, with forty-eight illustrations. Besides the three editions published in England, two have been published in U.S.A., two in Germany, one in Hungary, and one in Italy. Altogether, a practical book of great interest, well arranged and printed, and at a moderate cost.

SOLAR DISTURBANCES DURING NOVEMBER, 1911.

By FRANK C. DENNETT.

THE Sun has shown more activity so far as spots were concerned, but there has been a marked decrease in the amount of faculic disturbance. Of the twenty-eight days on which observations were possible the disc presented an apparently clear unruffled surface on nine, namely the 7th, 8th, 11th, 14th, and 16th until 20th, whilst only a little faculic disturbance was visible on the 5th and 6th nearing the western limb. The longitude of the central meridian at noon on November 1st was 240° 48′.

No. 38.—This group, consisting of one small spot as leader, possessing three umbrae, and followed by eight pores, broke out suddenly on November 1st. Its length was 38,000 miles. On the 2nd only the spot was seen at the western end of a coarsely granulated area; it dwindled on the 3rd and 4th, when last seen, the area being marked during the next two days by the above-mentioned faculic disturbance.

No. 39.—On the 9th and 10th the position of this little pore was carefully measured. On the 11th nothing was seen, but on 12th and 13th in the same area, or very near to it, one and two tiny pores respectively were seen, but their exact positions could not be determined owing to the combined difficulties of minute size and rapidly travelling cloudiness.

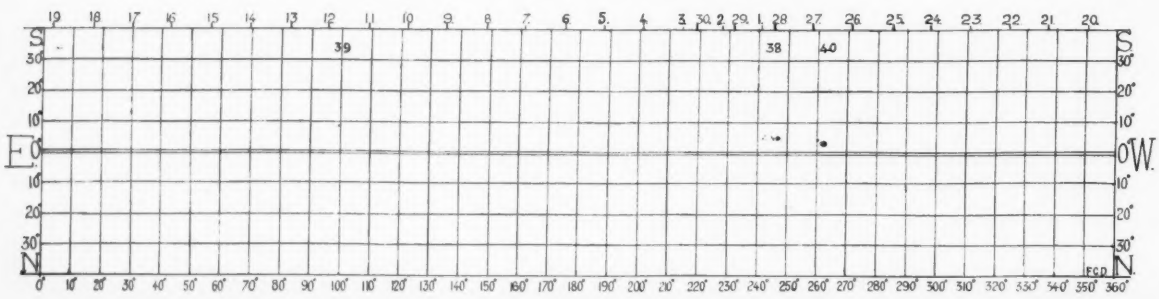
No. 40.—A fine spot was seen to have come round the limb on the 21st, rimmed on the western side by faculae. There were two umbrae, and when last seen on the 29th the inner edge of the penumbra was bright edged. Its diameter was 14,000 miles. There was a pore a little south-east on the 24th.

Within the eastern limb on the 28th there was a small faculic disturbance.

Not only is there a falling off in activity when the Sun is examined with the telescope alone, but there is a similar decrease in the number of prominences and other phenomena shown with the spectroscope.

Our chart is constructed from the joint observations of Messrs. John McHarg, E. E. Peacock, and F. C. Dennett. The wide distribution of the observing stations at Lisburn, Bath, and Hackney proves very helpful in preserving the continuity of the record.

DAY OF NOVEMBER, 1911.



NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

I BEGIN my notes by expressing my sense of the loss that Astronomy has sustained in the death of Mr. W. T. Lynn. His name has become well-known throughout the astronomical world for his laborious researches connected with the biographies of astronomers and the clearing up of obscure points in astronomical history. His little books on Comets and Eclipses did much to spread a knowledge on these points, and their popularity is shown by the frequent new editions that were called for. His birth appropriately coincided with the appearance of Halley's Comet in 1835, so that his life was practically coeval with a revolution of the comet.

He worked to the last, having read a paper before the British Astronomical Association in November, and contributed letters to the recent and forthcoming numbers of the *Observatory*.

ARE THE WHITE NEBULAE GALAXIES?—If one opens an astronomical text-book of some sixty years ago one will probably find it supporting the view that the nebulae as a whole are external Galaxies. When the spectroscope revealed the gaseous nature of many of them this view was generally abandoned, and it was supposed that all the nebulae were within our Galaxy. Mr. R. A. Proctor strongly supported the latter hypothesis, arguing that as we cannot resolve all parts of our own Galaxy it is extremely unlikely that we can see external ones. He seems to have overlooked the consideration that bodies which have sensible discs do not lose in surface-brightness, but only in size, when the distance is increased (assuming that no light is absorbed in traversing space).

The ancient view is now being revived in many quarters, as far as the white nebulae (those with a continuous spectrum) are concerned. Sir David Gill recently advocated it in a lecture delivered before the Royal Institution, and *Astr. Nachrichten*, No. 4536, contains an article on the same subject by Professor F. W. Very. He takes the great Andromeda nebula as his standard; its longer axis (neglecting faint outlines) is 110′. He calls the distance of this nebula one "Andromede," and endeavours to find it on the following two suppositions:—(1) that its real diameter is equal to that of our Galaxy, its distance is sixty Galactic radii; (2) assuming that Nova Andromedae belonged to the nebula, and that its intrinsic brightness at maximum was equal to that of a Galactic star of zero magnitude, its distance is twenty-five Galactic radii. On the latter assumption it is much smaller than our Galaxy. Professor Very takes the mass of the Galaxy as equal to twenty million suns, and deduces that of the nebula as one and a-quarter million suns.

He takes the distance of our Galaxy as some sixty light-years, which appears to be too small, seeing that according to this value the Galactic stars should have large proper motions, and these in reality are very small. On this basis, and adopting the value twenty-five for the ratio of distances, he takes the distance of the Andromeda nebula as one thousand six hundred light-years. The smallest of the white nebulae have diameters about one six-hundredth of that of the Andromeda nebulae, whence their distance would be a million light-years. He finds some evidence for the absorption of light in space from the fact that the smaller nebulae appear also to be intrinsically fainter (surface for surface). He takes the transmission through a distance of one "Andromede" as 0·996. Through six hundred and twenty-five Andromedes it would be 0·082, or only one-twelfth of the light would reach us.

Still another confirmation of the fact that the Galactic stars are on the whole beyond the region of sensible proper motion has been given in a paper by Mr. Bellamy in *Monthly Notices* for November. He has examined the larger proper motions of stars in the zone between 24° and 26° North Declination, from pairs of plates taken at an interval of some ten years, with the following result:—

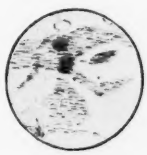
Mean Galactic Latitude.		Mean No. of Stars per Plate.		Mean No. of P.M.'s per Plate.
4°·9	...	315	...	5·9
21°·2	...	247	...	5·7
37°·3	...	128	...	4·6
58°·7	...	85	...	5·1
78°·7	...	74	...	4·8

Only proper motions exceeding one-tenth of a second per annum are included. It will be seen that while there is a slight increase in the number of proper motions near the Galaxy, it is not at all in proportion to the increase in the number of stars, showing that the Galactic stars lie beyond the region of easily detected motions. Professor Very is conscious of the difficulty, but endeavours to evade it by suggesting that the absolute velocities of stars in the Galactic system are smaller than in the Sun's neighbourhood, on the analogy of the diminution of planetary velocities, as their distance from the sun increases; but it is to be noted that even if we grant this as regards their absolute motion, the motion of the solar system would still give them a large apparent motion. It is fairly well established that the sun moves through some four astronomical units per annum, which, if unforeshortened, would give a star at sixty light-years distance an apparent motion of one-fifth of a second per annum; the Galactic stars certainly show no motion approaching this amount, whence it appears certain to me that the Galaxy is far more than sixty light-years distant, so that all Professor Very's estimates of Nebular distances would need multiplication by a considerable factor.

It is, of course, by no means certain that, even if the white nebulae are composed of stars, they are external Galaxies; they may well be miniatures of the Galaxy included within its limits. The fact that these nebulae as a whole shun the Galactic Circle, and are somewhat clustered about its Poles, presents a considerable difficulty to the theory of their being external.

FIGURE 39.

Mars, 1911, October 11th. λ=70°.



H

FIGURE 40.

Mars, 1911, November 14th. λ=55°.

H

FIGURE 41.

Mars, 1911, November 14th. λ=94°.

Sketches made at Flagstaff.

NOTE.—The region marked H indicates the supposed morning frost.

PHOTOGRAPHS OF MARS.—Professor Lowell has sent me three plates, each containing twenty exposures of Mars. The first was taken on October 11th by Mr. Slipher (longitude of centre of disc 70°). It shows Aurorae Sinus, Lacus Solis, Tithonius Lacus, Argyre, and traces of several canals. The pair of plates taken on November 14th (longitudes 55° and 94° respectively) show the same general region of the planet (see Figures 40 and 41); their special interest lies in the white patch at the bottom of the disc, to the right of the polar cap, which Professor Lowell considers to be morning hoar frost; comparison of the two pictures shows that it does not move on with the surface details, but clings to the morning limb, and this certainly supports the hoar frost theory. The plates bring out much variety in the depth of shading of the Maria, and show some indication of the canals across these; the sketches given here

are only rough, but may serve to indicate the principal details shown on the plates. A recent journal of the Astronomical Society of Canada contains a reproduction of a beautiful photograph of Mars taken by Professor Barnard at Yerkes in 1909. Those taken in that year with the great reflector at Mt. Wilson were very successful in showing the various shadings on the Maria, but broke down in fine detail; a refractor has the advantage in this respect. We have reached a stage when photography may claim to be a real aid in our study of the planet.

ENCKE'S COMET.—The reason of the large discordance between prediction and observation in the positions of Encke's comet last summer has been detected. Through an unfortunate erratum the ephemeris was computed from elements in which the eccentric angle was 10′ too small. A corrected ephemeris has now been formed, and Professor Backlund gives in *Astr. Nachrichten*, No. 4539, a comparison with the observations. The values of observed minus computed quantities are as follows:

Place.	Date, 1911.	Observed R.A.	Computed. Dec.	No. of Nights.
Algiers ...	... July 31 ...	$-1^s\cdot58$ ...	$+ 8''\cdot3$ ...	1
Cape ...	... Sept. 6 ...	$+0^s\cdot14$ ...	$+ 4''\cdot6$ ...	8
Johannesburg ...	Sept. 9 ...	$+0^s\cdot03$ ...	$- 4''\cdot8$ ...	11
Santiago,Chili ...	Sept. 24 ...	$+1^s\cdot41$ ...	$-26''\cdot3$ ...	1

It is clear from these figures that the predicted date of perihelion is very nearly right, and Dr. Backlund concludes that his value of the mass of Mercury 1/9,700,000 is confirmed, and that the acceleration of the mean motion of the comet suffered a notable diminution about the time of perihelion in 1904.

SCHAUMASSE'S COMET.—The eighth cometary discovery of 1911 was made on November 30th, by M. Schaumasse, an assistant at the Nice Observatory. It was only of the twelfth magnitude but will probably be of at least the tenth in January. The elements are:—

$$T = 1912, \text{Feb. } 5\cdot35, \text{G.M.T.}$$
$$\omega = 109^\circ\ 8'$$
$$\Omega = 115^\circ\ 12'$$
$$i = 20^\circ\ 29'$$
$$q = 1\cdot170$$

Position on January 1st, R A $15^h\ 17^m\ 52^s$, S. Dec. 1° 47′, daily motion $+ 4\frac{1}{2}^{min}$, South 15′. It is a morning star, rising some 5^h before the Sun.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

STRUCTURE OF CLOSTERIUM.—Two interesting papers have recently been published on the structure of this beautiful genus of Desmids, by Lutman (*Bot. Gaz.*, April, 1910 and June, 1911). *Closterium* is a large genus (with about sixty British species, for instance), and is easily recognised by its elongated cell, which is usually curved and often markedly semilunar in form, tapering at each end to a pointed tip or pole. At each pole, there is a vacuole containing minute particles of calcium sulphate, suspended in liquid and showing vibratory movement; *Closterium* is also interesting as showing active streaming movements of the protoplasmic layer within the cell-wall.

In his first paper, Lutman shows that the descriptions hitherto given of the structure of the chromatophore or chloroplast are inaccurate. His methods of sectioning the plants with the microtome show that each of the two chromatophores consists of a hollow cone bearing relatively narrow longitudinal ridges on its outer surface—the number of these ridges is greater than has been previously described, and they may be as many as eighteen and rarely fewer than twelve. Apparently it is practically impossible to count the number of the ridges accurately except in sections. All previous writers on this Desmid have described the chromatophore as consisting of a solid longitudinal axile rod bearing a number of radiating plates. Lutman shows, however, that this is not the case and that in cross section the chromatophore does not resemble a hub with radiating spokes, but is more like a coarsely-cogged wheel. The protoplasm in the furrows between the ridges of the chromatophore is frequently much denser in structure than the chromatophore itself, but contains numerous vacuoles of varying sizes; however, there are great differences in this respect, and sometimes this protoplasm is reduced to a mere network occupied almost entirely by vacuoles. The external appearance of the plant is determined largely by the density of the protoplasm between the ridges; sometimes the plants are so dark green as to be almost opaque, at other times much lighter green and semi-transparent.

Lutman then describes the pyrenoids in the two species of *Closterium* studied by him; in *C. ehrenbergii* they are embedded in the outer portion of the chromatophore, while in *C. moniliferum* they are situated exactly at its centre and are arranged in a single row along the central axis of the cell. In addition to the layer of starch which encloses each pyrenoid there are numerous starch grains lying free in the protoplasm, usually in longitudinal rows along the ridges of the chromatophore. The free starch grains exactly resemble the pyrenoid ones, being angular at the edges and concave and clearly originated around a pyrenoid. It is difficult to say whether these free starch grains became free by a second layer of starch being formed around the pyrenoid and crowding out the old layer, or by the breaking-up of the pyrenoids themselves. In size the pyrenoids vary from bodies almost impossible to see with the highest magnification to spheres whose diameter is one-fifteenth that of the *Closterium* body itself. The starch is present as a layer of irregularly-shaped grains, but sometimes more than one layer is suggested by the appearance of other grains just outside the regular layer. No two pyrenoids are alike as to the shape of the grains around them; there is no stratification visible in either grains or pyrenoids. Where strands of protoplasm run across the central part of the cell body, they tend to be oriented on the pyrenoids, exactly as in *Spirogyra*, and so on; this arrangement, which is doubtless connected with the streaming movements of the protoplasm, puts the pyrenoid in quick communication with all parts of the cell, and facilitates the movement of food materials toward and away from it. The pyrenoids may be angular or rounded; they often contain denser and lighter portions, and sometimes a vacuole; they often divide up into a number of discs or segments of varying number and form. If plants are kept in darkness for a few days, the starch around the pyrenoids rapidly disappears, while the pyrenoids themselves are found to have diminished one-third to one-fourth in size—showing that some of the pyrenoid substance has been used up.

In his second paper, Lutman deals with the structure and division of the nucleus in *Closterium*. The nucleus lies at the central and thickest part of the cell, between the two chromatophores, and has the form of a double convex lens. It consists of a fine network of lightly-staining fibres, with a mass of deeply-staining granules in the centre. The first external sign of division is a pinching-in of each of the two chromatophores, at about a third of the distance from middle to tip of the cell, as if it were being constricted by a rubber band around it at each of these two places. The chromatophore, in fact, seems to divide in the way the entire cell divides in animals like *Amoeba*. Meanwhile, the nucleus proceeds to divide, and after the chromosomes have been drawn to the two poles, and across the middle of the cell, there now appears a broad granular band in which the new cell-wall is formed. The two new nuclei then pass along, within the cell-wall, to the new position they are to occupy permanently in the new cell at the middle of each chromataphore. Soon after the new cross-wall is put in at the middle of the Desmid, the new end begins to round out, but the two individuals hang together for quite a time with only a slight connection, which finally breaks, the individuals separating before the new halves are at all symmetrical with the old ones.

Lutman deals with the apparently unequal division of the chromatophore. A *Closterium* plant is, apart from its curvature, composed of two cones placed base to base, and when the chromatophore in each half divides, by a plane

parallel to the base of the cone, we get a cone and a frustum formed, the cone being longer than the frustum and apparently much larger. On determining the *volumes* of these two portions, however, the surprising fact is revealed that the cone has not more than two-thirds the cubic contents of the frustum. However, the blunt (frustum) portion includes half of the large nucleus of the plant and of the large vacuoles around the nucleus, which do not appear in the cone end. This blunt end is the one which has to undergo reconstruction, a process requiring the using up of a good deal of material like starch, of which this portion contains more than the cone. Hence this new half cannot be said to "grow out" in the sense of having to grow in order to become as large as the pointed end, since it contains quite as much material as the old end. There is a re-shaping of this material, but both ends take part in the growth that is to produce again a normal size in the individual.

The division process in the two species of *Closterium* examined by Lutman occurs at night time, and takes two nights for its completion. The chromatophore divides the first night; while on the second night the nucleus divides, between 10 p.m. and 5 a.m., the new half becoming practically symmetrical with the old one by 9 a.m. *Closterium* as seen in the daytime has its chromatophore divided into halves, resulting from the chromatophore division of the preceding night, and the two halves are also to be regarded as a preparation for the division of the nucleus and cell the following night—providing it has succeeded in storing enough food material to make the process possible.

Leaving aside some interesting points in reference to nuclear division, especially the relations between the central mass (nucleolus) of the nucleus and the formation of the chromosomes, Lutman's observations clear up various questions regarding the structure and affinities of the Desmids. In *Closterium* itself, for instance, the method of origin of the two daughter chromatophores by constriction explains the fact that the ridges of the chromatophore on each side of the nucleus correspond. The continuity of the outer granular layer of protoplasm, in which the streaming occurs, is explained by the fact that the constriction of the dividing chromatophore is due to a ring-like vacuole formed within this granular layer, which is, therefore, not divided but is left intact and enables active streaming to take place between the two halves of the cell.

Again, the process of cell division supports the view that the Desmids have arisen from filamentous Algae. The new cross-wall grows inwards as a widening ring from the peripheral cell-wall, in exactly the same way as in *Spirogyra*, and it is only as the two new cells separate and the pressure is relieved on one side of this wall that its shape changes. If the cells did not separate, a filament being formed, each cell of the filament would be essentially like a cell of *Zygnema* with its nucleus at the middle, and a half of the symmetrical chromatophore on either side. The pointed shape which the new end assumes is clearly a secondary character, and we may assume that *Closterium* (and, therefore, the Desmids as a whole) arose from filamentous forms, which developed the habit of breaking up into single cells.

The great majority of the Desmids are unicellular, but a tendency to form filaments is seen in various genera, as *Cosmarium*, *Euastrum*, *Staurastrum*. The view that the Desmids have arisen from filamentous forms, and are what may be called a degenerate group, explains various points in their structure and biology, *e.g.*, the highly-specialised external characters of the cell and cell-wall, and the loss of sexual differentiation of the conjugating cells.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

INTERNATIONAL ATOMIC WEIGHTS FOR 1912.—The Committee of International Atomic Weights has issued its report and table of atomic weights to be used in the coming year. The list now numbers eighty-two elements, having been increased by the addition of niton, the name given to the emanation of radium. This substance is a gas belonging to the argon group. Its atomic weight, determined by means of a micro-balance, was calculated to be 223, but from other considerations the value 222·4 is regarded as the more probable and is the one given in the table.

Determinations made during the past year have resulted in trifling alterations being made in the values of calcium, erbium, iron, tantalum and vanadium, while the experiments of Easley (*J. Amer. Chem. Soc.* 1910, XXXII, 1117) have caused the committee to change the atomic weight of mercury from 200·0 to 200·6. This is the most important alteration in the table. As in the case of the last few years the whole of the values are compared with oxygen as 16, and hydrogen as 1·008, and the alternative values based upon hydrogen as unity are no longer published.

MARINE FIBRE.—A new textile fibre has recently been put upon the market under the name of "Marine Fibre," and is sold at about £5 per ton. It is derived from the bottom of Spence Bay in South Australia, and notwithstanding the fact that it is soft and not very strong, it may be spun in admixture with wool and other fibres. It differs from sea-weed in structure and composition, and appears to have originated from some land plant, such as New Zealand flax. An account of its chemical characteristics is given by Messrs. Green and Frank (*Journ. Soc. Dyers and Colourists*, 1911, XXVII, 169), who point out that the high proportion of salt which it contains renders it almost non-inflammable. It may be easily dyed with basic dyestuffs, in which respect it resembles jute, but it has little affinity for acid dyestuffs or sulphur dyes.

STERILISATION OF WATER BY ULTRA-VIOLET RAYS.—The use of the ultra-violet rays for the sterilisation of water is now in general use, and various types of apparatus have been patented. Among the most recent of these is the apparatus of Henri Helbronner and von Recklinhausen of Paris (Eng. Pat. 4895, of 1911), in which a mercury vapour lamp enclosed in a quartz chamber is immersed in the water, while a ball-float or similar device prevents the action of the lamp taking place until the liquid has arisen above the level of the quartz chamber.

A main essential for effective sterilisation is that the liquid shall be relatively transparent to the radiation, since liquids containing colloidal bodies (gelatine, peptones, and so on), absorb the rays, with the result that only the immediate surface becomes sterilised. For this reason, as has been shown by Rolle, (*Woch. Brau.*, 1911, XXVIII, 533) the process cannot be used for the sterilisation of malt liquors.

In the case of clear water, however, the sterilisation is so rapid that a simple apparatus has been devised by Rogier to be attached to a water tap. This consists essentially of a cylindrical mercury vapour lamp in a quartz chamber, which is surrounded by an aluminium tube narrowing at one end, so that the water comes close to the lamp on its way. It will give a yield of two hundred to three hundred gallons of sterile water per hour.

The large plant installed at Marseilles for the sterilisation of the drinking water works at a cost of 1·1d. per thousand gallons, but this cost might be reduced by about half, and would then be cheaper than sterilisation by ozone. According to Courmont (*Chem. Zeit.*, 1911, XXXV, 806) the sterilising process does not depend upon the formation of ozone or hydrogen peroxide.

CARBON MONOXIDE DETECTOR.—A simple and effective apparatus, for detecting traces of carbon monoxide in the air has been devised by Dr. Nowicki (*Oesterr. Zeit. Berg.-u. Hüttenw.*, 1911, LIX, 587), and should be found of great use in mines. It consists of a glass vessel, the inlet and outlet of which are provided with stopcocks. The air to be tested is forced through the vessel by means of a rubber bulb, until the air inside the flask has been displaced. The stopcocks are then closed, and a note taken of the time required to blacken a strip of filter paper moistened with palladium

XUM

chloride solution, and suspended in the vessel before applying the test. When the air contains carbon monoxide in excess of 0·1 per cent., the paper will shows signs of darkening within about one minute, while as little as 0·01 per cent. will affect the paper within about eleven minutes.

COMPOSITION OF SOME EARLY MATCHES.—A paper has been read before the Chemical Society by Mr. E. G. Clayton (*Proc. Chem. Soc.*, 1911, XXVII, 229) in which are given some interesting particulars of the characteristics and composition of some of the earliest matches put upon the market.

The so-called "Promethean" matches, introduced in the early part of last century by Samuel Jones, consisted of a mixture of potassium chlorate, sulphur and other substances, which was ignited by contact with sulphuric acid, supplied separately in a small glass tube.

Then in 1826-7, the first "friction lights" were invented by John Walker. The main constituents in these were sulphur, antimony sulphide and potassium chlorate, and they were ignited by being drawn between strips of sand paper. Their success led to the manufacture of similar "friction lights" by Samuel Jones (the originator of "Prometheans"), and to these he gave the name of "Jones' lucifers" or "Chlorate matches."

The following analyses show the percentage composition of some of these early matches in use prior to the introduction of phosphorus matches:—

Non-phosphorus Matches.	Sulphur.	Potassium Chlorate.	Lycopodium.	Gum.	Antimony Sulphide.	Ferric Oxide.
"Promethean"* ... Matches (1828)	24·7	34·9	8·8	31·6	—	—
"Lucifer" Matches I. (1832–3)	6·5	27·6	—	35·7	24·6	5·6
"Lucifer" Matches II. (1832–3)	12·5	41·0	—	24·9	18·1	3·5

* Ignited by dilute sulphuric acid coloured with indigo.

Soon after the introduction of "lucifer" matches, the first phosphorus matches were manufactured. They were sold under the name of "Congreve matches," and were probably so called after Sir William Congreve, who invented the war rocket.

These matches, large quantities of which were made abroad, and especially in Germany and Austria, contained ordinary phosphorus, and also differed from the lucifers in being ignited by being "struck upon the box." The composition of two kinds of these matches, the first probably representing the earliest phosphorus matches sold in England, is shown in the following examples taken from Mr. Clayton's long table:—

Phosphorus Matches.	Ordinary Phosphorus.	Sulphur.	Potassium Chorlate.	Chalk	Dextrin.	Gum.	Dye.
German... ... (about 1835)	20·5	14·3	32·1	8·0	25·1	—	Trace of blue dye.
Austrian ... (1845-1850)	17·8	11·5	37·4	—	—	33·3	—

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

PLIOCENE FLINT IMPLEMENTS.—Momentous discoveries of flint implements have been recently made in East Anglia—one, by Mr. J. Reid Moir, in the detritus-bed at the base of the Red Crag in Suffolk; and another, by Mr. W. G. Clarke, at the base of the Norwich Crag in Norfolk. These sub-crag implements are described by Sir Ray Lankester (Meeting of Royal Society, November 16th) as of a novel type which cannot be associated with any yet known from other localities. This type is called the rostro-carinate or "eagle's beak," and includes also scrapers, hammers, and large one-sided picks. The rostro-carinate implements are compressed from side to side, and are thus distinguished from the Chellian and Mousterian types, which are flattened like a leaf. They were manufactured prior to the period of severe glaciation, and are thus older than any previously known on equally good evidence. On account of the affinities of its molluscs Sir R. Lankester is disposed to believe that the Red Crag should be grouped with the Pleistocene rather than the Pliocene. The race of men who made the rostro-carinate implements are believed to have lived near the sea in the time of the Coralline Crag. Some of the implements were washed into the detritus-beds at the base of the East Anglian Crags, but others remained on the land surface, and were subsequently included in glacial sands and boulder-clays, in which a few have now been found. In view of the importance of the announcement, it is to be hoped that indisputable evidence will be forthcoming that the implements really came from the beds named, as there are so many possible sources of error attending the discovery of implements in deposits earlier than the Pleistocene.

ORIGIN OF THE DIAMOND.—The fascinating problem of the genesis of diamonds receives further attention from Dr. O. H. Derby (*Journ. Geol.*, Oct.-Nov., 1911), who puts forward a new speculation as to the origin of the gem. As is well known, diamonds occur, at least in South Africa, in pipes of volcanic origin which are filled with a peculiar ultra-basic rock called "Kimberlite." This rock is invariably much fragmented and altered, and contains numerous foreign inclusions (xenoliths), both of igneous and other origin. The weight of evidence is in favour of the diamonds being assigned to the eruptive rock proper, and not to the xenoliths included in it. Dr. Derby believes that a positive, and perhaps genetic, relation exists between the diamond and the fragmental condition of its matrix, basing his opinion on the experiments of Gardner Williams, who crushed twenty tons of the eclogite boulders or segregations from the Kimberley Mine without finding a single diamond. This association of diamond with fragmentation means that the origin of the diamond is to be assigned to reactions between the rock constituents, made possible by the explosive and disintegrating action of the agency that formed the Kimberley pipes. Under this view the extensive hydration and carbonation of the Kimberley rock is due to deep-seated pneumatolytic action rather than to atmospheric weathering. Kimberlite from the deepest part of the De Beers Mine (2,040 feet), still contains 6·81 per cent. of combined water, and it is improbable that this can be due at that depth to atmospheric weathering. Dr. Derby presents a new hypothesis of the origin of the diamond on the assumption of the deep-seated origin of the alteration of the diamond matrix. He believes that the Kimberlite pipes were saturated with hot (possibly superheated) gases and liquids, and constituted huge crucibles in which carbon would be present at least in the form of carbon dioxide, and probably in other gaseous forms. Thus the material and some of the physical conditions for unusual carbon segregation would be present, and it is possible that, under these conditions, diamonds would be formed. The suggestion is made that the rôle of carbon in eruptive phenomena generally would be an attractive subject for experimental researches such as could be carried on in the Geophysical Laboratory of the Carnegie Institute at Washington.

GLACIATION OF NORTH ARRAN.—The sculpture of the mountains of Arran, the most beautiful of the Clyde islands, has recently been studied in detail by Mr. F. Mort (*Scottish Geog. Mag.*, Dec., 1911.) These mountains consist of a mass of granite with a nearly circular outcrop; and whilst never reaching three thousand feet in height, constitute some of the finest mountain scenery in Great Britain, in consequence of their sharp spiry summits, serrated outlines, deep valleys, and great precipices. This remark applies particularly to the eastern mountains grouped about Goatfell. To the west the

forms become soft, rounded, and full-bodied, the altitude sinking to less than two thousand feet. This contrast is due to the fact that the western hills owe their smooth outlines to the work of the great ice-sheet which once covered the island, whilst the higher Goatfell group became subsequently a centre of independent glaciation. Its originally smooth outlines have consequently been destroyed, the rounded ridges have been narrowed into gashed and serrated arêtes, great corries or cirques have been gouged out of the mountain sides as if by a gigantic cheese-scoop; whilst deep U-shaped valleys have been carved, in which the existing streamlets appear as almost ludicrous "misfits," and whose tributaries form beautiful hanging-valleys.

The Arran mountains rise from a well-marked plateau at a level of one thousand feet above the sea. This plateau is built of such diverse rocks as Schist, Old Red Sandstone, Triassic, and Granite, and has a most immature drainage, presenting an example of extremely youthful topography. This is taken as proof of its recent origin. It is believed to represent the remains of a peneplain of marine denudation, and doubtless belongs to the one thousand foot platform so well developed in the adjacent Grampian Highlands.

Mr. Mort reaches the same conclusion in regard to Arran as does Professor W. M. Davis in regard to the Snowdon group, namely, "that a large-featured, round-shouldered, full-bodied mountain of pre-glacial time has been converted by erosion during the Glacial Period—and chiefly by glacial erosion—into the sharp-featured, hollow-chested, narrow-spurred mountain of to-day."

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended November 18th, as set out in the Weekly Weather Report issued by the Meteorological Office, was mostly dull and unsettled. Over a large portion of the kingdom rain was experienced daily, some of the amounts being very large. Sleet or snow were common in the N. and E. of Scotland late in the week. Aurora was observed in Scotland on the 16th, and thunder was heard in Ireland on the 17th.

Temperature was above the average in all districts except Scotland, N., the excess reaching 4°·6 in England E. The highest readings reported were 60° at Hillington and 59° at Hereford. The lowest readings were 24° at Baltasound, 25° at Nairn, and 26° at Kilmarnock. In Ireland the minimum was 35°, and in the English Channel 43°. On the grass readings down to 20° (at Llangammarch) were observed.

Rainfall was in excess very generally, and was more than double the average in many places. At Tunbridge Wells the total for the week was 2·67-ins., as compared with an average of 0·78-ins. Bright sunshine was in defect in all districts except Ireland N., where it was normal, and in the English Channel, where it was just above.

The mean temperature of the sea-water ranged from 41°·0 at Kirkwall to 52°·9 at Newquay.

The week ended November 25th was cold generally, the defect as compared with average reaching 5·0 in Ireland S. The highest reading was 53° at Guernsey on the 20th, but at a number of stations the maximum did not exceed 45°. The lowest readings were 21° at Balmoral and 22° at Birr Castle. On the grass very low readings, down to 10° (at Llangammarch), were noted. Rainfall was in excess of the average in Scotland E. and England N.E., but was in defect elsewhere. In Scotland W. the week was almost rainless, the district value being only 0·02 inches, as compared with an average of 1·19 inches. Sunshine was in excess in the Western districts, but was in defect in the English Channel and was about normal elsewhere. Valencia reported the largest aggregate, 33·2 hours (57%), while at Westminster the total was only 2·2 hours (4%).

The average temperature of the sea water ranged from 40°·4 at Kirkwall to 51°·5 at Newquay.

During the week ended December 2nd, the weather over the United Kingdom was changeable, but not very wet. Snow and sleet were experienced in the North and East, and thunder was heard at Kilmarnock on December 1st.

Temperature did not differ greatly from the normal. It was a little above the average in Scotland, England, N.W., and Ireland, N.; in other districts below it. The highest reading was 56°, reported from Glencarron, Hawarden Bridge and Markree Castle. The lowest readings were 20° at Nairn, and 21° at Strathpeffer. Frost was observed in every district except the English Channel, where the minimum was 34°. The lowest reading on the grass was 17° at Llangammarch.

Rainfall was below the average in all districts except England N.E. In England S.E. and the English Channel it was but little more than half the usual amount. There were no stations without rain, and at several places rain was measured on each day. Sunshine was scanty; the sunniest district was England S.W., with 17 hours (30%), but England E. had only 4 hours (8%). The sunniest station was Newquay with 22·3 hours (39%). Westminster reported 1·8 hours (3%).

The mean temperature of the sea water varied from 40°·0 at Kirkwall to 48°·3 at Scilly and at Plymouth.

The week ended December 9th was very unsettled, but with bright intervals. Snow and sleet were experienced in some Northern districts, and thunder accompanied by hail occurred at Westbourne on the 6th.

Temperature was below the average very generally, the greatest deficiency being in Ireland S. The highest readings were 57° at Pembroke, and 55° at Cambridge and Dumfries, on the 3rd. The lowest of the minima was 21° at Balmoral on the 8th. The English Channel was again the only district which was free from frost in the air, although at Guernsey there was a reading of 27° on the grass. The lowest reading on the grass for the week was 12° at Llangammarch Wells.

Rainfall was in excess in all districts except Scotland N. In England S.E. and S.W. and in Ireland S. the totals were more than double the average, and at many stations rain was measured on each day of the week. In spite, however, of the frequent and heavy rains sunshine was considerably above the normal in all districts, the percentage of possible duration ranging from 46° in the English Channel to 24° in Scotland N., which was just double the average in each case. The sunniest station was Salcombe, 32·5 hours (58%). At Westminster the aggregate was 12 hours (22%). The temperature of the sea water varied from 39° at Ballantrae to 51° at Scilly.

The week ended December 16th was mild and wet. Slight thunderstorms were reported, and Aurora was seen in Scotland on the 11th and 14th.

Temperature was above the normal in all districts, the excess amounting to nearly 4° in England S.E., and the Midland Counties. The highest reading was 55° at Waterford with 54° at several stations. The lowest of the minima were 23° at Balmoral, 27° at Killarney, and 29° at Nairn. At no other station did the temperature fall below 30°, and indeed in six out of the eleven districts into which the United Kingdom is divided for Meteorological purposes the temperature did not fall below the freezing point. In the English Channel the lowest reading was 41°. On the ground the lowest temperature reported was 20° at Balmoral.

Rainfall was greatly in excess, except in Scotland N. Falls of more than an inch in twenty-four hours were frequent, and at Crathes the fall on the 15th amounted to 2·03 inches. At many stations the total for the week was more than double the average. Sunshine was also in excess of the average over the greater part of England though slightly below in Scotland and Ireland. The sunniest district was England E., with 15 hours (29%); the sunniest station being Torquay with 19·3 hours (35%). At Westminster the total was 10·9 hours (20%). The temperature of the sea water ranged between 40° and 50°.

XUM

RAINFALL AND PHTHISIS.—A research conducted by Dr. William Gordon, physician to the Royal Devon and Exeter Hospital, has led the author to some interesting and important conclusions with regard to the influence of rain-bearing winds upon the prevalence of phthisis. Taking certain Rural Sanitary Districts in Devonshire, he classified the parishes comprised in the several areas according to their exposure to the W. and S.W. winds, which are in Devonshire the rainy winds, into I, sheltered parishes, II, exposed parishes, and III, imperfectly sheltered parishes, and then carefully collated the deaths from phthisis in these parishes during a series of years.

To his great surprise he found that the death-rate in the parishes exposed to W. and S.W. winds was generally double, sometimes more than double, that in the parishes sheltered from those winds, and this irrespective of the *amount* of the rainfall in the various places. Thus, of two contiguous parishes with a hill between them the parish on the windward side of the hill was found to have twice as many deaths from phthisis, per thousand of the population, as that on the side sheltered from the S. and S.W., but exposed to the N. and E., and this although the amount of the rainfall on the leeward side of the hill was in many cases greater than that on the windward side.

The areas selected were situate, two in the northern part of the county and two in the southern part, and the results were so consistent as to justify further inquiry. This further inquiry was conducted both in detail and on a broad scale, and the results arrived at fully confirmed those first reached. In the wide inquiry the various counties were taken as units, and subsequently larger areas still; in the detailed inquiry the City of Exeter was taken, street by street, and both lines of research led to the same result, namely, that the important point to consider in the choice of a residence for persons suffering from phthisis is the incidence of the rain-bearing winds of the locality, exposure to which is a more serious factor than the altitude of the place, the character of its soil, or even the amount of its rainfall.

FIGURE 42.
Dorsal surface, × 44, showing the so-called ear-like processes.

FIGURE 43.
Side view of Palpus, × 120. Inside, showing the two teeth. Drawn from a male specimen. Male and female alike.

FIGURE 44.
Foot of fourth leg, × 160.

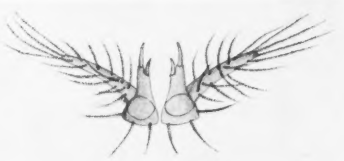


FIGURE 45.
Method of carrying palpi in front. Drawn from the front of an unmounted specimen, × 160.

MICROSCOPY.

By O. B. JECTIVE,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD. ARTHUR EARLAND, F.R.M.S.
THE REV. E. W. BOWELL, RICHARD T. LEWIS, F.R.M.S.
JAMES BURTON. CHAS. F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN. D. J. SCOURFIELD, F.R.M.S.
C. D. SOAR, F.L.S., F.R.M.S.

AN INTERESTING EARTH MITE UNRECORDED IN GREAT BRITAIN.—One Summer day in 1909, I was seeking in my garden for some fresh mites or spring-tails, and so on, when I saw on the stone steps leading up to the house, a mite (Figure 42) moving at a very rapid pace, and progressing in quite an unusual manner. It was advancing in a zigzag manner, but in the form of curves, each curve being about five to six inches long, and advancing about one to two inches at a time. Sometimes it would make a wider sweep of about half a circle, and occasionally, when apparently it came across an active prey, it would whirl round in small concentric circles with such velocity as to envelop and secure it, and sometimes it would stop so suddenly that the eye was carried on and for the moment lost the mite.

As an instance of the ferocity of this mite, I saw a Spring-tail, I believe a *Degeeria*, several times the size of the mite, resting on a window-sill. The mite was advancing in its usual zig-zag manner towards it, but not seeing the spring-tail until within six or eight inches from it; then the mite rushed at the spring-tail. For a moment the turmoil was something to see, but it ceased as suddenly as it had begun, the mite was alone, the spring-tail having escaped with a motion too rapid for the eye to notice. Having moved in March, 1910, to another part of Plymouth, I was afraid I had lost my little visitors, especially as I did not find them at the old home, which I occasionally visited for that purpose; no doubt it was mainly owing to the inclement year, but to my delight in the early summer of this year (1911) I found them busy on my window-sill, and again on a low wall underneath my window. Apparently they nested in the border bell-flower (*Campanula carpatica*), which I had sent up to my new abode, a singular coincidence that this mite living amongst hundreds of blue bells, should be furnished with ears.

I found on placing the mite under a low power, × 35, that it was a dark orange-red mite with brown markings, but with two perfectly white ear-like processes (in shape triangular), situated immediately behind the eyes. Then putting it under × 200 I saw a beautiful comb-like arrangement under and across the end of the abdomen, and projecting beyond it. This I found afterwards to be the male. The female is in all respects like the male, except it is without the comb-like process shown in Figure 46.

I have always found it active, seeking its food on stone, and never on flowers, flower bed, or grass adjoining. I have also found them on my bedroom window-sill, about twenty feet from the ground, where a pair had taken up their abode between the wood and stone-work, so I hope next summer to have a further and better opportunity of studying them. The front of the house over which they travelled is built of stone.

It is apparently *Erythacarus parietinus*, Herm., but neither Hermann's figure 1804, nor Koch's 1835-41, nor Berlese's, have the ears which is such a beautiful and distinct character in this mite, so it would appear to be:—As *Erythacarus parietinus* with ears. Super family,

FIGURE 46.
Posterior margin ventral surface of male, showing the comb-like arrangement of bristles, × 64.

Erythacarus parietinus Herm.

Trombidoidea; family, Erythracidae; genus, Erythracus (since altered by Berlese to *Erythacarus*, because the type *Erythracus* is a Rhyncholophus).

References:—Hermann, J. F., "Memoire Apterologique," page 37. Table 1. Figure 12. Strasburg, 1804.

Koch, K. L., "Deuschlands Crustaceon," 1835-41, 16. 23.

Berlese, F., 11, No. 4. Figure 2.

The length of the mite is 0·96 millimetre. The figures to illustrate my note were kindly drawn by Mr. Chas. D. Soar, F.R.M.S.

A. W. ALABASTER.

DARK GROUND ILLUMINATION AND ULTRA-MICROSCOPIC VISION.—The letter on the above subject by Mr. E. Leitz is of considerable importance, for it is eminently desirable that a proper understanding of the province and limitation of the accessory apparatus used in the production of dark ground illumination should be clearly defined.

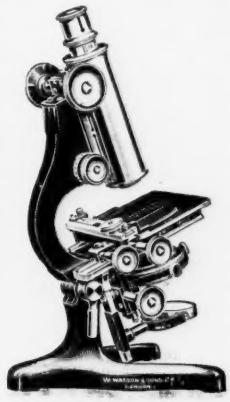


FIGURE 47.

Particularly striking is the fact mentioned by your corresspondent, that neither dark ground illumination nor the so-called Ultra-Microscope is a means of enhancing the resolving power of the Microscope. Mr. Nelson pointed this out some considerable time ago, and it has now been ascertained that for an objective to utilize its full resolving power the numerical aperture of the Dark Ground Illuminator must be three times that of the Objective. As under present conditions the maximum numerical aperture of the Illuminators is 1·35, it follows that the effective aperture of all Objectives exceeding ·45 is reduced. There is actually a greater resolving power with dark ground illumination with Objectives having numerical apertures in excess of ·45, but it is very substantially less than that which is yielded with direct light; so much so that if we take 1·35 as the limit of numerical aperture for both condenser and objective, the resolving power obtainable with dark ground illumination is approximately that yielded with a numerical aperture of ·65 with ordinary direct illumination, while if the practical limit of the objective be considered, namely 1·0 N.A., in conjunction with a condenser of 1·35, the resolving power obtained is only equal to that of an objective of ·59 with direct illumination. It therefore follows that the perception of fine structural detail is not so much a feature with dark ground illumination as the increased contrast afforded, and the practical advantage of the use of high powers lies chiefly in the greater magnification.

The well-known phenomenon of a streak of sunlight passing through a small opening into a darkened room revealing dust particles which in full daylight cannot be seen, is the explanation of the effect produced in microscopical dark-ground illumination when minute particles otherwise invisible are revealed, and even with so simple a piece of apparatus as the spot lens with a one-inch objective, starlike objects and specks which by direct illumination would be invisible are clearly seen and come under the category of "ultra-microscopic." And so through the whole range of dark ground immersion condensers, and finally the special apparatus known as the "Ultra-Microscope" the same law applies, only the method differing, and there is the same limited resolution that is implied by the physical limitation of the total numerical aperture of the condenser referred to previously.

Undoubtedly great confusion has arisen in the minds of microscopists in consequence of the multiplication of dark ground illuminators of various kinds, especially those which have enabled objectives of high magnification to be employed, and for the sake of clear understanding, and to avoid any chance of confusion, it would be well to sharply differentiate the apparatus into three classes :—

1. To comprise the Spot Lens and all the means until recently provided for low power dark ground illumination, which might be classed as "Low Power."
2. All the modern Illuminators which have for their purpose the use of high power objectives and particularly the revealing of living bacteria, and so on, which could be classed as "High Power."

And finally, the entirely distinct arrangement which depends on illumination at right angles to the optical axis through a slit, which could be known as the "Ultra-Microscope."

I commend these brief notes to the consideration of your readers, with the hope that someone more capable than myself may pursue the matter further.

M. I. CROSS.

A NEW MICROSCOPE.—W. Watson & Sons, Ltd., have recently introduced a Microscope of new design, the "Bactil Mk. IV," which follows the lines of some well-known Continental models, but combines the special features which distinguish all the Watson Microscopes. See Figure 47.

It will be noticed from the illustration that the fine adjustment is set on the side of the limb, the rotation of the controlling milled head being read on a divided drum. This milled head actuates a lever set in a vertical position. The freedom from complications, certainty of action, and the very slow movement that can be obtained is well known in the lever form.

The mechanical stage is not of the usual attachable kind, but is built to the instrument and gives a horizontal range of movement of two inches. A very neat feature of this stage is the method of gripping the object slip. Hitherto this has been dependent on a spring action pulling down a curved finger-piece. This has always been open to the objection that the immersion oil, especially if thick, exercised a retarding influence on the slip, and this, pressing against the spring referred to, caused it to give very slightly, with the result that when high powers were in use there was an apparent loss of time on change of direction of the mechanical screw of the stage. This is obviated in this new pattern, the finger-piece being set by means of a milled head, and being immovable excepting by its means.

By an ingenious arrangement the whole of the stage can be removed from the dove-tailed fittings and a plain stage substituted for it if desired.

The substage is of the regular English pattern with rack-work to focus and screws to centre. It also lifts aside from the optical axis.

The sprung fittings to frictional surfaces, the large body tube, the long range of coarse adjustment for use with low power objectives, the advantage of which is so well-known, are retained in this model. It is of solid and handsome construction throughout.

APPARATUS TO FACILITATE THE ILLUMINATION OF OPAQUE OBJECTS WHEN VIEWED BY THE AID OF THE VERTICAL ILLUMINATOR (Figure 48).—This apparatus, suggested by Mr. J. E. Barnard, F.R.M.S., consists of a small right angle prism, fixed to an arm, which is clamped to the nosepiece of the microscope by the screw of the vertical illuminator, and has universal movements. It will be found most useful when photographing opaque specimens such as metals, and so on. In use the Microscope Stand is placed in a horizontal position and the illuminating beam thrown by the aid of a bullseye condenser upon the right angle prism; it is then projected through the diaphragm of the vertical illuminator, and so on through objective to specimen; the diaphragm of vertical illuminator must of course be directly under the right angle prism. By this means of illumination the position of vertical illuminator may be varied when objectives of different power are used without the beam of light being altered, one of the inconveniences experienced when the vertical illuminator is illuminated from the side, and to overcome which many metallurgical microscopes are provided with rack adjustment to the stage. In

photographing opaque specimens with the vertical illuminator it is usual to remove the illuminating system from the optic axis to the side of the microscope, and this necessitates a special bench or support, but with the right angle prism the illuminating system has only to be raised to the same height as the prism, which can be done in a few minutes.

ROYAL MICROSCOPICAL SOCIETY.—November 15th, Mr. C. F. Rousselet, the curator, exhibited and described an old microscope bearing the name of Andrew Pritchard, which Capt. Warrington had discovered in India and had presented to the Society.

It was probably made by Andrew Ross for Pritchard, who sold microscopes made for him by Ross and Hugh Powell. The date to be assigned to it would be between 1834 and 1838. Mr. Rousselet also described another microscope from India, lent by Mr. A. H. Lethbridge. It was a combination of a pocket telescope and microscope. The eyepiece of the telescope being removed and screwed into a "drum" form of stand constituted a low-power microscope of itself, and on removing the field lenses of the eyepiece "French-buttons" can be screwed on giving higher magnifications. The name inscribed on the apparatus is Charles Nephew and Company, Calcutta. The date is uncertain, but would be some time after introduction of the "French-button."

The Society exhibited, under Microscopes, a number of slides of Rock-sections from Australasia, presented by Mr. H. J. Grayson and cut by him by his improved apparatus. Mr. J. E. Barnard read a paper on "A Geometric Slide Photomicrographic Apparatus." Mr. Barnard said the apparatus was designed on the principle of the geometric slide throughout, as enunciated by Lord Kelvin and Tate. The base of the apparatus was formed of two castings designed on the girder principle, braced together at each end and in the middle. The portion to carry the microscope was also formed by a pair of castings braced together in the same way. Great rigidity was obtained, and the whole apparatus would move together if subjected to shock or vibration. Rods were fastened down on the top of the castings to support the apparatus, and the camera slid along these on two V grooves on one side and on a plane surface on the other side. The camera was supported on vertical rods fixed on the geometric slides. The apparatus could be used equally well as a horizontal or vertical camera, or at an angle of 45°.

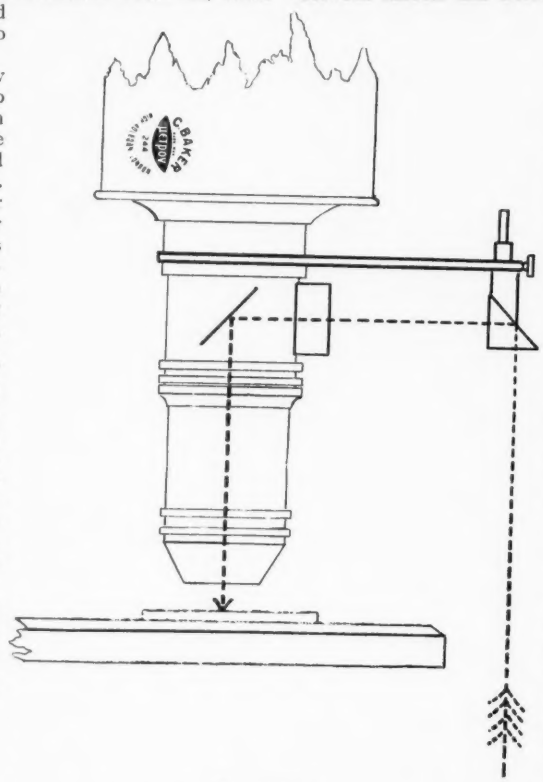


FIGURE 48.

A paper on *Fridericia*, by Rev. Hilderic Friend, F.L.S., was read. The genus *Fridericia* was created by Michaelson, in 1889, to receive certain species of Enchytraeids, eleven in number, possessed of dorsal pores, and having setae of unequal lengths. In 1895, Beddard reckoned twelve species, but not one was known as British. Moore, Friend and others added to the list which in 1900 stood at twenty-one. Bretscher, Issel and others then took up the study, and at the present time some seventy or eighty species of *Fridericia* are known to science. The largest is *F. magna* Friend, which has been found in England, Ireland and Scotland, but so far has not been reported abroad. The author, whose researches into this genus began in 1896, here reports no fewer than thirty species found up to the present time in the British Isles. Some of these are new to science, and a series of keys is appended to enable the student readily to distinguish the allied species.

The following were elected Ordinary Fellows of the Society:—Hamilton Hartridge, Chas. Hy. Huish, Malcolm E. MacGregor, Lewis Noad, Henry Blatch Wells.

QUEKETT MICROSCOPICAL CLUB.—November 28th, Dr. J. J. Simpson gave a lecture on "The Relationship between Insects and Disease." In the animal kingdom no group is more intimately connected with the bionomics of the world than that designated by the general name "Insects," and no group is so prolific in its effects both for good and evil. The part played by insects in connection with disease is threefold. (1) as actual parasites; (2) as mechanical transmitters; (3) as intermediate hosts of pathogenic organisms. Specimens of each of these classes were exhibited and described. A list was given, under the third group, of the diseases transmitted and the hosts responsible for their spread. To Mosquitos are due Malaria, Yellow-fever, Elephantiasis and Dengue in man; Horse-sickness in Transvaal, and Filariasis in man. The Tsetse fly is responsible for Sleeping-sickness in man and Nagana in horses and cattle. The Tabanidae cause Surra in cattle; *Stomoxys*, Mal de Caderas in horses; *Hippobosca*, Galzieht in cattle; Fleas transmit Plague; Sand-flies, Pappataci Fever in man; Ticks, Relapsing Fever in man, and Texas, Redwater, Rhodesian, Biliary, and other fevers in cattle, horses and sheep, Spirochaetosis in fowls and Malignant Jaundice in dogs. And who can say how many more? Several of the more important of these diseases were described at length and an interesting account was given of the prophylactic measures adopted. One of the first problems to be solved in this connection is the distribution and life history of all blood-sucking insects, an enormous task, but one that is being slowly and surely accomplished.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

WILLOW GROUSE IN SCOTLAND.—Last shooting season (1911) three white Grouse were shot at Glendarüel, Argyllshire, and seem to have been something of a puzzle to the shooting party at the time. It is explained, however, that on the neighbouring estate of Glenstriven some Ryper (*Dalripa*, Swedish) or Willow Grouse (*Lagopus albus*) which had been sent from the far north of Sweden, were put down some years ago in the month of April. They were placed in an enclosure on the hill with one wing slightly clipped, but they soon escaped and were scattered about the country. The remains of two or three, killed by hawks, were found; and those now reported shot are probably others which survived till then.—(*The Field*, 18th November, 1911, page 1129). Our native Red Grouse (*L. scoticus*) and the Willow Grouse have separate geographical ranges, but they are of common origin and the last-named might well establish itself as a breeding species in Scotland, given the opportunity, to which ornithological purists are strongly averse. It has,

however, been turned down on several shootings, and in Banffshire, in 1909, it was reported to be so much at home as to breed pretty freely with the Red Grouse, the offspring turning out shapely, vigorous and healthy.

COMMON BIRDS NESTING AT HIGH ALTITUDES.—In the British Isles the nests of a few species of birds are found only at a considerable elevation above sea level, but some of our common birds associated with the lowlands are occasionally found making their homes upon the hills. Last summer (1911) Mr. Seton P. Gordon saw, on 28th July, a Swallow's nest with one fresh egg at an old shooting lodge in the vicinity of a Highland loch at an altitude of about one thousand six hundred feet, and he remarked that it closely resembled that of a Grey Wagtail which had nested on the same beam (*Country Life*—11th August, 1911, p. 274). The Swallow's near neighbour, the House-Martin, was breeding in numbers at the beginning of August under the eaves at Swarthgill, the highest-up house in Wharfedale (about one thousand three hundred feet). Further north, and at the same elevation (one thousand three hundred feet), on the Lui Water, Mar Forest, Aberdeenshire, there used to be (1902 and 1903) a nesting colony of about thirty pairs of the delicate little Sand-Martin and the spot may be still frequented. On the great Deeside Hill, Lochnagar, on 7th July, 1903, three pairs of Swifts were found to be haunting the highest summit (three thousand seven hundred and eighty-six feet). They kept going in and out of a crevice which could not be got at, but it was well seen in the brilliant sunshine of a very fine day and the birds were kept under observation for about an hour. Enquiries failed to ascertain if there was positive proof that they were nesting, and an opportunity of re-visiting the place has not yet fallen to our lot.

RECOVERY OF MARKED BIRDS.—Some further returns are given in the December number of *British Birds* (V, pages 186-188), the most noteworthy being:—

Linnet (*Linota cannabina*)—marked at Hampton-in-Arden, Warwickshire, 26th May, 1911; recovered near Bordeaux, France, 25th October, 1911. Another marked near Reading, Berks, 6th June, 1911; recovered at Sabres, Landes, France, 25th October, 1911.

Starling (*Sturnus vulgaris*)—marked at Viborg, Denmark, 7th October, 1911; recovered near Shropham, Norfolk, 12th November, 1911.

Cormorant (*Phalacrocorax carbo*)—marked at Saltee Island, County Wexford, 26th June, 1910; recovered at Audierne, Finistère, France, 16th November, 1911.

Common Tern (*Sterna fluviatilis*)—marked at the Summer Isles, Ross-shire, 5th August, 1911; recovered near Oporto, Portugal, at the beginning of October, 1911. Another marked at Loch Thom, Renfrewshire, 22nd July, 1911; recovered near Aveiro, Portugal, 11th October, 1911.

Black-headed Gull (*Larus ridibundus*)—marked in Schleswig, 25th June, 1911; recovered at Breydon, Norfolk, 27th October, 1911.

COMMENSAL NESTING.—One of the photographs in Mr. Clinton G. Abbott's recently published book on "The Home-Life of the Osprey" (1911) shows a large nest on a tree-top in Gardiner's Island, near New York. An Osprey is sitting by the nest and a Purple Grackle about to enter its home in the same nest, and also a Woodpecker's hole in the branch of the tree directly below. Mr. Abbott explains that smaller birds often use the sides of the Osprey's huge abode to nest in, and that Purple Grackles especially, being gregarious, may be found to the number of six or seven pairs in one nest-structure. They live in perfect harmony with their host. House-Sparrows have been seen by Mr. Abbott utilizing Ospreys' nests and House-Wrens and even Night-Herons have been recognized elsewhere as its tenants. In nests on the ground Meadow-Mice construct their run-ways in the mounds. Such nesting partnerships are unusual amongst birds, but the Ospreys and their tenants undoubtedly find some mutual advantage in this close association.

THE FLIGHT OF BIRDS AS SEEN FROM A MOTOR CAR.—A correspondent writes:—"Running along these country roads an observant eye will see a good deal of life. Birds, startled by the sudden appearance and strange sound, fly out from the hedgerows, as often as not crossing the road immediately in front, uttering their notes of alarm, whilst some will fly in front or alongside for some distance before they swerve aside to alight in a convenient field. The apparent ease with which many of the smaller birds will keep up with, and even gain upon, a car which is travelling at the rate of twenty-five and more miles an hour, provides a startling illustration of their different powers of flight. Twenty to twenty-five miles an hour seems to be about the ordinary speed in flight of most of the birds inhabiting the hedgerows. Other birds, such as the swallow, will, in their ordinary flight, pass a car when it is travelling at as high a speed as forty miles an hour."

THE BODY TEMPERATURE OF BIRDS.—At a meeting of the Royal Society of Edinburgh, on 20th November last, a communication on "Observations on the body temperature of some diving and swimming birds" was made by Professor Sutherland Simpson, M.D., D.Sc. He said that observations had been made on the body temperature of a large number of diving and swimming birds of eighteen different species in the Orkney Islands and in the Firth of Forth, in Scotland, and on and around Caynga Lake, New York, U.S.A., immediately after they were killed by shooting. In all the species examined where the sex was determined it was found that the temperature of the male was slightly below that of the female. Of the orders examined the highest temperatures were found in the Longipennes, and the lowest in the Tubinares. When arranged according to body temperatures the series did not run parallel with the zoölogical series.

PHOTOGRAPHY.

By EDGAR SENIOR.

PRINTING WITH SALTS OF IRON, URANIUM, AND SO ON.—Having had occasion lately to make a number of prints in which the salts of iron, chromium and uranium were the sensitive agents, it was thought, from the beauty of the results obtainable, together with the simplicity of the process, that the subject might form matter interesting to photographic students, and those requiring a method for readily obtaining a record of general forms of objects such as seaweeds, fern or other leaves, lace, and so on. The general principle upon which the formation of the images is based is that of reduction, light reducing the ferric and uranic salts to ferrous and uranous, and these, when treated with certain re-agents, producing suitably coloured deposits. For nearly the whole of our knowledge concerning the action of light upon iron salts we are indebted to Sir John Herschel, whose experiments date back nearly seventy years. The iron salt usually employed as giving the most certain results is that known as the double citrate of iron and ammonium citrate, which is obtainable in two varieties in the form of scales, one of which is brown, the other green, in colour. We much prefer the green scale preparation, as it is more sensitive, and gives better results generally. Whichever preparation is used, a solution is made containing about forty grains dissolved in one ounce of distilled water; or, in the case of the green scale preparation, enough of the salt may be taken to make quite a dark green-coloured solution, no weighing being necessary.

Paper, "ordinary writing paper answers perfectly," is coated with either of the above by means of a piece of sponge or cotton wool used for filtering purposes, spreading the solution evenly over the surface with a circular motion. The coating operation should be performed by artificial light or in a dimly lighted corner of a room. The paper may be dried in front of a fire, taking care not to scorch the surface, and is then ready for exposure, or it may be kept between the leaves of a book for some short time until required for use. Our own experience however is, that freshly prepared paper answers best.

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The objects from which it is desired to obtain images are laid upon a piece of glass placed in a printing frame, and the paper placed with its coated surface in contact; the whole is then exposed to light for a time varying from five minutes in a bright light to twenty minutes or more in a dull one. However, as the change brought about is a visible one, the progress of printing may be watched, examining the print in some well-shaded position; especially so is this necessary with paper prepared with the green ferric-ammonium citrate, on account of its increased sensitiveness.

If ordinary negatives are used to print from (and excellent results can readily be obtained in this way) care must be taken not to over-expose; in fact, the printing must not be carried to such a stage that the detail in the lights becomes visible, otherwise a general flatness of the picture will result. The negatives employed must be fairly strong ones, it being useless to attempt to use poor thin ones. The change in colour during exposure to light is from a greenish-yellow to a pale greyish-brown, a little experience soon enabling one to judge when the printing has been carried far enough. On removal from the printing frame development may take place at once, or the paper may be placed in a book until a more convenient time. Experience, however, shows that too long a time should not be allowed to elapse between the two operations. In order to develop the print it is laid face upwards in a porcelain dish, and a solution of potassium ferricyanide (red prussiate of potash) of about twenty grains in an ounce of water poured over. Development is almost instantaneous, the print assuming a fine blue colour due to the ferrous salt resulting from the action of the light reacting with the ferricyanide of potassium, and producing a precipitate known as Turnbull's blue, having the composition $Fe_3Fe_2Cy_{12}$. After development the prints are placed in water containing a little sulphuric or hydrochloric acid, then washed in several changes of water and dried. Prints made by this process are very stable, although soaking in water certainly weakens them. A variation of the process may be made by applying to the exposed paper a dilute and neutral solution of gold chloride, when a purple image results, owing to the ferrous salt reducing the gold salt to the metallic state. Sir John Herschel gave the name of Chrysotype to these prints.

A variation in the method described above by which blue prints may be obtained direct without development may be made by mixing together the ferricyanide of potassium and the ferric salt, and applying the same to paper. The following will be found a good formula:—

1.	
Potassium ferricyanide	60 grains
Water (distilled)	1 ounce
2.	
Ferric ammonium-citrate...	70 grains
Water (distilled)	1 ounce

These two solutions should be mixed together and kept in the dark. When required for use a little is taken and spread over paper, as already described, which when dry is ready for use. When the action of light has gone far enough, "which is ascertained by examination," the print is removed from the frame and placed in water containing a few drops of sulphuric acid, and afterwards washed in several changes and placed to dry. To make uranium prints the same procedure as described above is employed, using a strong solution of uranium nitrate of about one hundred grains in one ounce of water in place of the ammonio-citrate of iron. Development of the prints with potassium-ferricyanide gives brown prints. If we mix uranium and the iron salt, and apply this to paper, a grey print results on development; in fact, mixing of the salts in varying proportions is found to give, in many cases, rather pleasing results.

EXPOSURE TABLE FOR JANUARY.—Although weather conditions during the next month or two may not be altogether conducive to outdoor photography, there may be occasions when opportunities present themselves for this class of work. We therefore give a table containing a few exposures that may be found useful. The calculations are made on the actinograph for plates of speed 200 H. and D., the object a near one, and lens aperture F 16.

Day of the Month.	Condition of the Light.	Time of Day. 11 a.m. to 1 p.m.	10 and 2.	3 p.m.	Remarks.
Jan. 1st	Bright	·4 sec.	·5 sec.	1·0 sec.	If the subject be a general open landscape take half the exposures given here.
,, ,,	Dull	·8 ,,	1·0 ,,	2·0 ,,	
Jan. 15th	Bright	·3 sec.	·4 sec.	·6 sec.	
,, ,,	Dull	·6 ,,	·8 ,,	1·2 ,,	
Jan. 30th	Bright	·2 sec.	·3 sec.	·5 sec.	
,, ,,	Dull	·5 ,,	·6 ,,	1·0 ,,	

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

THERMOSTATS.—The Faraday Society's Meetings are always marked by a degree of general usefulness, interest, and enthusiasm which is sometimes lacking in the proceedings of older societies. On Wednesday, December 6th, among the subjects for discussion was that of the construction and working of thermostats. Thermostats are arrangements for maintaining temperatures constant over a long period of time and are most necessary accessories to the study of most physico-chemical processes.

A thermostat consists generally of a bath of liquid which is maintained constant in temperature by means of a heater placed either inside or outside the bath. The heater, if used inside the bath, consists either in a bare electric resistance wire or an electric lamp; if used externally the heating is usually accomplished by means of a small gas burner. In each case some form of thermo-regulator, which switches on and off the current or turns the gas up and down, has to be employed. This thermo-regulator usually consists of a closed tube of liquid with low specific heat, high expansion coefficient, and small density which expands on rise of temperature: the liquid then presses on one side of the mercury contained in a U-tube, which on being raised in the other limb of this tube, closes either an electric circuit or the end of a tube through which the flow of gas to the burner is passing. In the first case, the electric current actuates an electro-magnet which switches out the electric heaters; in the other case the supply of gas is automatically cut down by closing the end of the tube mentioned and can only issue through a small opening in the side of this tube. An efficient stirring arrangement has to be used in the baths, otherwise a constant temperature cannot be maintained. These stirrers are constructed like a "screw" and are actuated by means of an electric motor.

Dr. Lowry has improved the thermo-regulator by making the tube containing the expanding liquid (usually toluene) as large as possible, so that the maximum amount of surface is exposed: there is then very little lag in the action of the regulator. This is accomplished by making the tube of spiral form.

Dr. Marshall gave a number of valuable hints as to the working of electrically controlled thermostats. The form of electric heater he advocates, is a form of elongated electric lamp which is switched in and out as before described, only the thermo-regulator actuates a relay which then switches out the main circuit; the relay being actuated by a single secondary cell kept permanently on the charge. A relay is a sensitive electro-magnet which responds to a weak current and makes an electric contact, which brings into action an electric current from a stronger source. The object of this is to obviate pernicious sparking on breaking the contact at the mercury surface of the thermo-regulator. Dr. Marshall also described a method of employing an ice thermostat for maintaining constant temperatures from 12° C to 0° C. This type of thermostat belongs to a different class, in which advantage is taken of the fact that substances melt

and boil at constant temperatures. Mr. Bousfield described a temperature regulator for use in an air bath. It consists of a large bulb of glass containing hydrogen. When this hydrogen is raised in temperature it expands and increases the pressure on a column of mercury in a barometer tube. When this occurs an electric contact is broken which switches out the electric heater. The mercury does not get attacked, because the circuit is broken in an atmosphere of hydrogen.

It is not easy to obtain a satisfactory method of maintaining constant low temperatures over a long period of time. There are a limited number of substances which can be used to maintain constant low temperatures, *e.g.*, boiling sulphur dioxide (−10° C), boiling liquid ammonia (−33° C), boiling sulphuretted hydrogen (−61° C), boiling nitrous oxide (−83° C), and boiling oxygen (185° C); also melting ether, melting nitrous oxide, and various "freezing mixtures," such as solid carbon dioxide and ether. But in all these cases a considerable quantity of the pure liquid is required, and the liquefaction is a troublesome process. Further, if these liquids are contained in a Dewar vessel, they supercool themselves unless evaporated by an electric heating arrangement.

The writer has recently been employing an arrangement for maintaining temperatures constant over a range of temperatures between +80 and −150° C, but has not yet published the method, as the details are hardly yet worked out. The general principle is that the thermometer, on rise of temperature of the bath liquid, makes an electric contact which switches in a heating coil situated in a closed bulb containing the bath liquid (*e.g.*, petrol); this bulb communicates with a spiral containing the same liquid immersed in a refrigerating agent; on heating the petrol in the top bulb, the pressure rises there and forces cold liquid from the spiral into the Dewar vessel which contains the bath liquid. The electric contact, owing to the fall in temperature, then breaks, and the liquid is sucked back into the spiral and recooled.

THE YEAR 1911.—It would not be possible to review the many advances made in the physical sciences during the year 1911 in the space of a few lines. One might direct attention, though, to the main regions of activity. There are usually one or two problems upon which the mind of man is concentrating its attack; other points in the line of resistance of the enemy remain in a more or less quiescent state. In radio-activity, Professor Rutherford and his collaborators have, by means of the beautiful scintillation method, investigated the scattering of the rays by atoms of various substances and have obtained valuable evidence on which to gain an idea of the structure of the atom. Professor Sir J. J. Thomson has concentrated his attention on the rays of positive electricity which stream back through a hole in the cathode of a tube in which a high vacuum is maintained. Others have investigated the positive rays emitted by incandescent solids and analysed the intricate actions which occur with some success. Secondary rays emitted from materials bombarded by X rays or corpuscular radiations have proved to be a problem of great interest and about which considerable controversy has been raised, Barkla and Bragg being the champions of the two views as to the nature of X rays. Then again there are the intensely interesting results of Professor Strutt, who has obtained a chemically active modification of nitrogen by means of an electric discharge, and has explained *en route* the peculiar glow effect obtained in certain circumstances with such discharges. Professor Woods' researches on the fluorescence from certain vapours lead to an idea of the vibrations and groupings of the electrons within the atom.

Professor Callendar has pointed out how the old idea of caloric may be of use in the study of thermodynamics, while the mechanism of the osmotic pressure of liquids is beginning to reveal itself. The motion of liquids in pipes and of solids through liquids has been submitted to careful experiment with useful results; while finally the theory of radiation and also of electric conduction and other fundamental physical properties has been advanced by means of what is known as the relativity principle, to which it will be well to devote a little space in the notes of the month of February or March.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

LARGE CUTTLEFISH.—It is always satisfactory to have precise figures in regard to big animals, and no fault can be found with the precision with which Mr. S. S. Berry has recorded the dimensions of a huge cuttlefish from Monterey Bay. Its total length was 1245 millimetres, that is rather over four feet; its length of body was 1180 millimetres. Its name is *Dosidicus gigas* (d' Orbigny) Pfeffer, and it is remarkable, in addition to its size, for some peculiar features in the suckers of the tentacles. The fine specimen is preserved in the University of California.

SELF-ADVERTISING ANIMALS.—Some animals walk delicately, some lie low, some fade into their surroundings, some put on disguise. On another tack, however, are those that are noisy and fussy, conspicuous and bold,—the self-advertisers. The theory is that those in the second set can afford to call attention to themselves, being unpalatable or in some other way safe. Mr. Pocock, of the Zoölogical Society's Gardens, has been recently applying this theory to various mammals, both at home and abroad.

Taking the common shrew, for instance, he points out that it is fearless and careless, and that it makes a frequent squeaking as it hunts. It can afford to be a self-advertising animal because of its strong musky scent, which makes it unpalatable. A cat will never eat a shrew. Similarly, the large Indian musk-shrew (*Crocidura coerulea*) is conspicuous even at dusk, fearless in its habits, and goes about making a peculiar noise like the jingling of money. But it is safe in its unpleasant musky odour.

The common hedgehog is comparatively easy to see at night; it is easy to catch, because it stops to roll itself up; it rustles among the herbage and "sniffs furiously" as it goes; it is at no pains to keep quiet. Nor need it, for although some enemies sometimes eat it, it is usually very safe, partly in its spines, and partly because it can give rise to a most horrible stench. The porcupine is another good instance of a self-advertiser, and so is the crab-eating mungoose (*Mungos cancrivora*).

HOW MUCH DOES A MOUSE SEE?—To look at a mouse one would think that sight counted for a great deal in its life, but Mr. K. T. Waugh's experiments go to show that this is only true within certain limits. Mice are good at distinguishing different degrees of illumination and different colours (preferring red and yellow to blue and green), and they are quick to detect movements, but they have very little sense of form and very little binocular vision. Microscopic study shows that the retina has no "rods" and no "fovea."

BRITISH FOSSIL SHREWS.—The remains of shrews found in the Norfolk "Forest Bed" and other British Pleistocene deposits have been hitherto referred to one or other of the three species at present inhabiting the country, namely *Sorex araneus* (or *vulgaris*), *Sorex minutus*, and *Neomys* (or *Crossopus*) *fodiens*. But a careful inquiry recently made by Mr. Martin A. C. Hinton shows that it is not until we reach the latest Pleistocene deposits that we meet with remains of species apparently indistinguishable from the living British forms. According to Hinton we must recognise at least three extinct species of *Sorex* and two of *Neomys*. He regards *Sorex* as standing in most respects on a slightly lower plane than *Neomys*. It retains one more premolar above; in the large lower incisor three or four denticles (primitively present upon the crowns of mammalian incisors) persist until an advanced stage of wear has been reached; the condyle of the lower jaw and its articulation are less highly modified. "In the small size of most of the species, the ir external characters, and the form of the skull and humerus we see the effects of an adaptation to life underground." The water-shrew (*Neomys*) has gone a little further and in a different direction, in adaptation to aquatic life, which has to some extent influenced its external characters. "A premolar has been lost above; the large lower incisor has been simplified—only one

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of the primitive denticles, in addition to that forming the point of the tooth, persisting; and the peculiar modification of the mandibular condyle, and the glenoid cup into which it fits, has proceeded further." Mr. Hinton has paid considerable attention to the dentition of the shrews, and it may be useful to note the formulae which he regards as most accurate:—

For *Sorex*:—i. $\frac{1.2.3}{1}$ c. $\frac{1}{1}$ pm. $\frac{+31}{1}$ m. $\frac{123}{123} = 32.$

For *Neomys*:—i. $\frac{1.2.3}{1}$ c. $\frac{1}{1}$ pm. $\frac{+ \ldots 1}{1}$ m. $\frac{123}{123} = 30.$

DOES A SNAIL SEE?—Field observations on the vineyard snail, *Helix pomatia*, suggest that the animal avoids the light. Willem's laboratory experiments, on the other hand, suggest that it prefers the light. Professor Emile Yung, of Geneva, has re-investigated the question, and finds that both these conclusions are wrong. He made over two thousand observations on one hundred and seventy-six snails, and found that they were quite indifferent to all sorts of light-stimulus, that they do not prefer lighted or shaded areas, that they do not see obstacles in front of them, and that their eyes have no visual significance at all.

EXOTIC CRUSTACEA IN BOTANIC GARDENS.—R. Menzel calls attention to the opportunities of studying exotic animals without leaving home. In the palm-house tank, in the Botanic Garden at Basel, he found an exotic *Cypris* (or *Stenocypris*). Outside he found *Cypretta* (*Cypridopsis*) *globulus* Sars, which has been described from Australia. Under flower-pots with earth brought from Java, he found what seems to be a new species of *Orchestia* (*O. senni*), doubtless of exotic origin, and interesting in being thoroughly terrestrial.

ASSOCIATION OF SUBERITES AND DROMIA.—A bright orange sponge (*Suberites domuncula*), is often found surrounding the gastropod shells inhabited by hermit-crabs, but the association has not been sufficiently studied. The sponge is unpalatable to many animals; it is full of strong flinty needles, and it has a strong odour. At the Naples Zoölogical Station Signor Polimanti has been recently studying the association between the Suberites and a crab (*Dromia vulgaris*). He has made this much quite clear, that the crab takes the initiative in getting the sponge on to its back and that the sponge affords its partner an effective protection against the appetite of cuttlefishes.

SELF-CLOSING PLANKTON NET.—Professor C. A. Kofoid describes a new model of Plankton net which he has tested extensively. The advantages which it has over other models are the following:—It can be opened or closed by the operator at any desired level in the sea, and it is not liable to interference from outside conditions. There is perfect and continuous closure of the net during descent and ascent. Nothing can enter, nothing can escape, unless the operator opens the net. The possibility of horizontal towing makes it feasible to effect a precise exploration of stratified waters. The vertical migrations of pelagic organisms can also be studied more effectively than before. The opening of the net is free from bars and ropes, which tend to ward off the more active animals. Professor Kofoid also describes a new self-closing water bucket, by which it is possible to collect twenty litres from any desired depth.

NOTICES.

A METEOROLOGICAL CATALOGUE.—We have received from Messrs. H. Sotheran and Company, an interesting catalogue of books on Meteorology and Terrestrial Magnetism. This is a comprehensive list of books on the subject, dated from the year 1269 to 1910, and includes the works of such pioneers as Descartes, Gilbert, Boyle, and Dalton. Some of the early books appear but seldom in sale catalogues. In addition there is given a list of books on Aviation and of periodicals and publications of learned societies.

SECOND-HAND INSTRUMENTS.—We have received Mr. C. Baker's January list of second-hand instruments for sale or hire. It consists of ninety pages and from it many of our readers should be able to choose, at a reasonable cost, apparatus for which they might not care to pay the full and original price. This list deals with telescopes, microscopes, objectives, cameras, and lenses as well as less generally used apparatus.

WHITAKER'S ALMANAC.—We welcome the forty-fourth annual volume which has appeared under the title of "Whitaker's Almanac." As it is or should be on everyone's writing table, we can say nothing which will make those who know it appreciate it more, while to those who have not made use of it we can only offer our respectful sympathy.

ZADKIEL'S ALMANAC.—This contains matters of interest to our astronomical readers, though mainly devoted to the astrology and predictions which may be based upon it. Messrs. Simpkin, Marshall & Co. are the publishers.

THE YEAR-BOOK OF SCIENTIFIC AND LEARNED SOCIETIES.—This, though primarily a book of reference, is interesting to glance through, while the lists of lectures given before the various societies offer useful suggestions to officials of institutions, and to lecturers who are looking out for new subjects. It should be on the shelves of every library and public institution, and is published by Messrs. Charles Griffin & Company.

METALLURGICAL MICROSCOPES.—The microscopic examination of metals now forms such a very important branch of engineering industries that Messrs. R. and J. Beck, Limited, have brought out a special catalogue dealing with the examination and photographing of metals. The list also contains descriptions of cameras for taking photomicrographs, and machines for grinding and polishing sections. A special microscope is illustrated which has been designed for the examination of the surfaces of the various kinds of blocks used for printing with letterpress.

"WHO'S WHO" AND ITS COMPANIONS.—The editor of "Who's Who" continues each year to discover a number of new people who are playing an important part in the world, and as a result the annual volume which Messrs. A. & C. Black publish becomes larger and more useful, while its price remains the same. The "Who's Who" Year Book, containing matters of interest crowded out of the original volume, is still issued annually by the same firm, which publishes also, for writers and authors, another annual volume with the intention of helping those who are getting their living by contributing "copy" or illustrations to the periodical press. "The English Woman's" Year Book comes from the same source and contains much general information, as well as a great deal concerning education, occupation, and entertainment of special interest to the gentler sex.

SCIENCE REFERENCE BOOK AND DIARY FOR 1912.—Messrs. James Woolley, Sons & Co.'s Science Reference Book and Diary has again been revised. Not only does it consist of a diary, calendars for the past and coming years, a dictionary of daily wants, a lighting-up time table, and list of scientific societies, but it has a second part, with a different opening, which contains a reference book on all matters dealing with science, such as atomic weights, physical constants, and test solutions, while scientific terms are explained, and other matters considered of importance in the everyday life of scientific workers. The price is 1s. 6d., which is no greater than that of an ordinary diary got up in similar style.